Pinnacle Telecom Group

Professional and Technical Services

Antenna Site FCC RF Compliance Assessment and Report

prepared for

AT&T

Site "P-05XT"
Long Hill Road
Long Hill, NJ

February 19, 2021

14 Ridgedale Avenue - Suite 260 • Cedar Knolls, NJ 07927 • 973-451-1630

Contents

Introduction and Summary

At the request of AT&T Wireless ("AT&T"), Pinnacle Telecom Group has performed an independent assessment of radiofrequency (RF) levels and related FCC compliance a proposed wireless base station antenna operation temporary monopole located on Long Hill in Long Hill, NJ. AT&T refers to the antenna site by the code "P-05XT", and its proposed operation involves directional panel antennas and transmission in the 700 MHz, 850 MHz, 1900 MHz, 2100 MHz and 2300 MHz bands licensed to AT&T by the FCC.

The FCC requires all wireless antenna operators to perform an assessment of potential human exposure to radiofrequency (RF) fields emanating from all the transmitting antennas at a site whenever antenna operations are added or modified, and to ensure compliance with the Maximum Permissible Exposure (MPE) limit in the FCC's regulations. In this case, the compliance assessment needs to take into account the RF effects of future antenna operations at the site by T-Mobile. Note that FCC regulations require any future antenna collocators to assess and assure continuing compliance based on the cumulative effects of all then-proposed and then-existing antennas at the site.

This report describes a mathematical analysis of RF levels resulting around the site in areas of unrestricted public access, that is, at street level around the site. The compliance analysis employs a standard FCC formula for calculating the effects of the antennas in a very conservative manner, in order to overstate the RF levels and to ensure "safe-side" conclusions regarding compliance with the FCC limit for safe continuous exposure of the general public.

The results of a compliance assessment can be described in layman's terms by expressing the calculated RF levels as simple percentages of the FCC MPE limit. If the normalized reference for that limit is 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. We can (and will) also describe the overall worst-case result via the "plain-English" equivalent "times-below-the-limit" factor.

The result of the RF compliance assessment in this case is as follows:

- At street level, the conservatively calculated maximum RF level from the proposed antenna operations at the site is 7.0863 percent of the FCC general population MPE limit – well below the 100-percent reference for compliance. In other words, the worst-case calculated RF level – intentionally and significantly overstated by the calculations – is still more than 10 times below the FCC limit for safe, continuous exposure of the general public.
- The results of the analysis provide a clear demonstration that the RF levels from the proposed antenna operations will satisfy the criteria for controlling potential human exposure to RF fields, and the antenna operations will be in full compliance with the FCC regulations and limits concerning RF safety. Moreover, because of the conservative methodology and operational assumptions applied in the analysis, RF levels actually caused by the antennas will be even less significant than the calculation results here indicate.

The remainder of this report provides the following:

- relevant technical data on the proposed AT&T antenna operations at the site, as we as on the future T-Mobile antenna operations;
- a description of the applicable FCC mathematical model for calculating RF levels, and application of the relevant technical data to that model;
- analysis of the results of the calculations against specified the FCC MPE limit, and the compliance conclusion for the site.

In addition, three Appendices are included. Appendix A provides background on the FCC MPE limit, as well as that of the State of New Jersey (see later). Appendix B provides a list of key FCC references on MPE compliance, and Appendix C provides a summary of the qualifications of the expert certifying FCC compliance for this site.

We recognize that the State of New Jersey has its own MPE limit, embodied in the Radiation Protection Act (also described in Appendix A) However, the State's limit is actually less protective of the general public (by a factor of five) than the FCC MPE limit. Thus, it is more appropriate to apply in the exposure assessment the more protective FCC limit. Compliance with the FCC's MPE limit automatically ensures compliance with the State's MPE limit, in this case by a factor of more than 50.

Antenna and Transmission Data

The table below summarizes the relevant data for the proposed AT&T antenna operation at the site.

General Data	
Wireless Frequency Bands	700 MHz, 850 MHz, 1900 MHz, 2100 MHz and 2300 MHz
Service Coverage Type	Sectorized
Antenna Type	Directional Panel
Antenna Centerline Height	85 ft.
Antenna Line Loss	Conservatively ignored (assumed 0 dB)
700 MHz Data	
Antenna Model (Max. Gain)	CCI OPA45R-BU5CA-K (15.4 dBi)
Total Input Power Per Sector	370 watts
850 MHz Data	
Antenna Model (Max. Gain)	CCI OPA45R-BU5CA-K (15.8 dBi)
Total Input Power Per Sector	160 watts
1900 MHz Data	
Antenna Model (Max. Gain)	CCI OPA45R-BU5CA-K (18.8 dBi)
Total Input Power Per Sector	160 watts
2100 MHz Data	
Antenna Model (Max. Gain)	CCI OPA45R-BU5CA-K (19.2 dBi)
Total Input Power Per Sector	160 watts
2300 MHz Data	
Antenna Model (Max. Gain)	CCI OPA45R-BU5CA-K (18.9 dBi)
Total Input Power Per Sector	100 watts

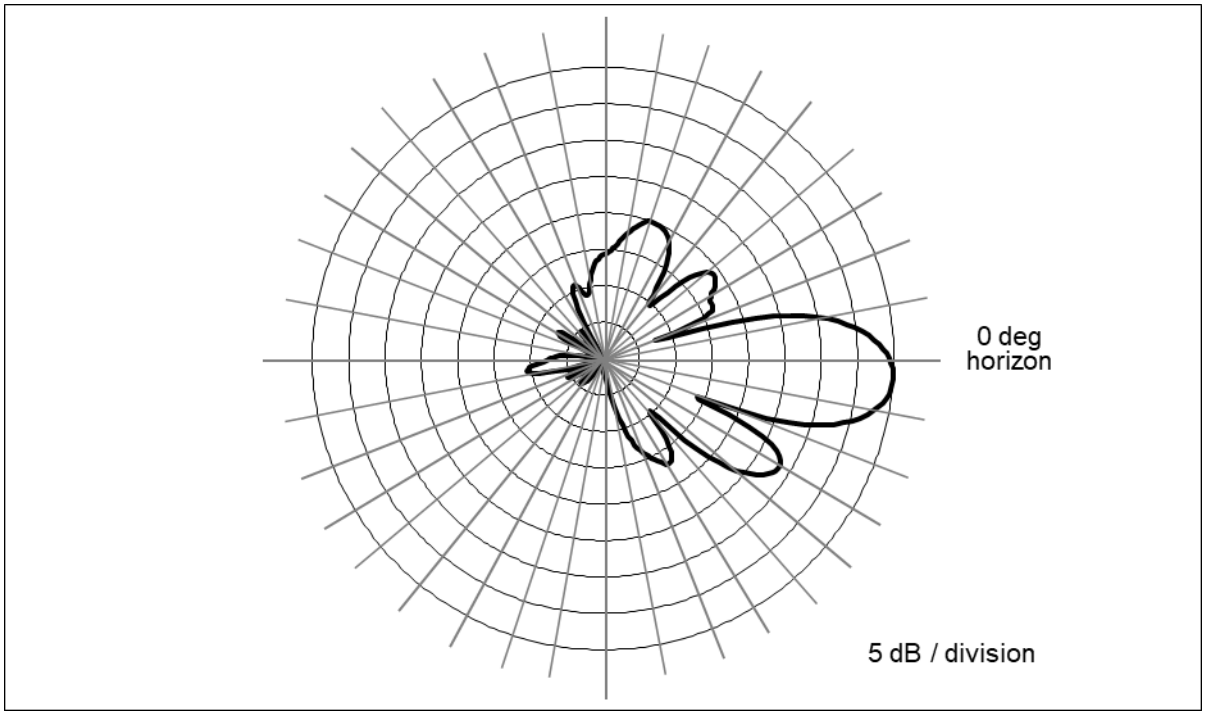
The area below the antennas, at street level, is of interest in terms of potential "uncontrolled" exposure of the general public, so the antenna's vertical-plane emission characteristic is used in the calculations, as it is a key determinant of the relative amount of RF emissions in the "downward" direction.

By way of illustration, Figure 1 that follows shows the vertical-plane radiation pattern of the proposed antenna model in the 700 MHz frequency band. In this type of antenna radiation pattern diagram, the antenna is effectively pointed at the three o'clock position (the horizon) and the relative strength of the pattern at different angles is described using decibel units.

Note that the use of a decibel scale to describe the relative pattern at different angles actually serves to significantly understate the actual focusing effects of the antenna. Where the antenna pattern reads 20 dB the relative RF energy emitted at the corresponding downward angle is 1/100th of the maximum that occurs in the main beam (at 0 degrees); at 30 dB, the energy is only 1/1000th of the maximum.

Finally, note 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. CCI OPA45R-BU5CA-K – 700 MHz Vertical-plane Pattern



As noted at the outset, there are future wireless antenna operations by T-Mobile to include in the compliance assessment, and we will conservatively assume operation with maximum channel capacity and at maximum transmitter power in each of its FCC-licensed frequency bands.

T-Mobile is licensed to operate in the 600 MHz, 700 MHz, 1900 MHz and 2100 MHz frequency bands. In the 600 MHz band, T-Mobile uses four 40-watt channels per sector. In the 700 MHz band, T-Mobile uses one 40-watt channel per sector. In the 1900 MHz band, T-Mobile uses one 40-watt channel and four 30-watt channels per sector. In the 2100 MHz band, T-Mobile uses one 40-watt channel and two 80-watt channels per sector.

Compliance Analysis

FCC Office of Engineering and Technology Bulletin 65 (“OET Bulletin 65”) provides guidelines for mathematical models to calculate the RF levels at various points around transmitting antennas.

At street level around an antenna site (in what is called the “far field” of the antennas), the RF levels are directly proportional to the total antenna input power and the relative antenna gain in the downward direction of interest – and the 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”, mirror-like reflection, which is the absolute worst-case scenario.

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

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

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
TxPower	=	maximum net power into antenna sector, in milliwatts, a function of the number of channels per sector, the transmitter power per channel, and line loss
$10^{(Gmax-Vdisc)/10}$	=	numeric equivalent of the relative antenna gain in the downward direction of interest; pattern data is taken from the antenna 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

The MPE% calculations are performed out to a distance of 500 feet from the facility to points 6.5 feet (approximately two meters, the FCC-recommended standing height) off the ground, as illustrated in Figure 2. below.

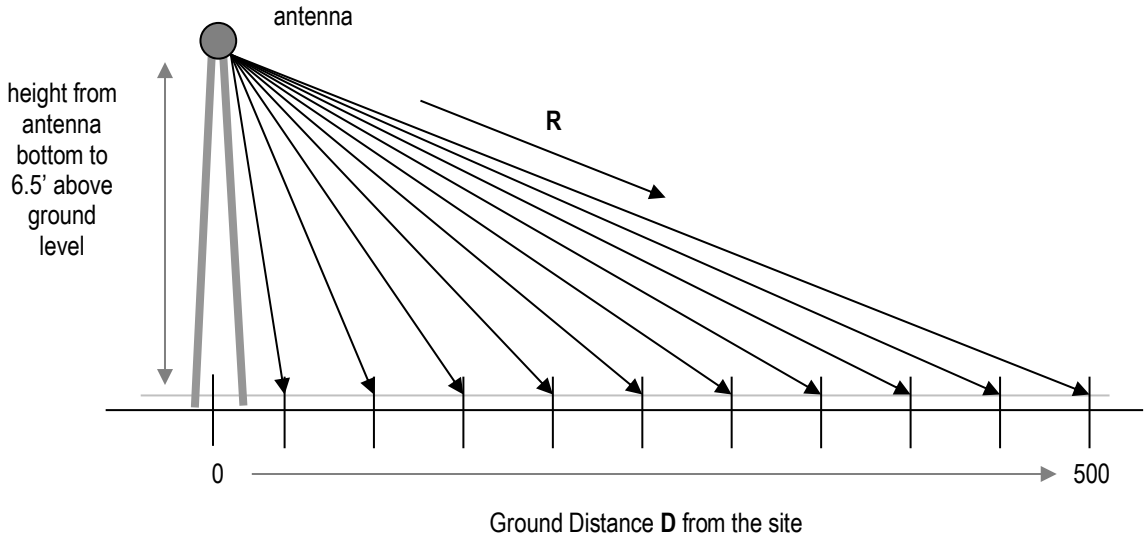


Figure 2. MPE% Calculation Geometry

It is commonly thought 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 site will reflect the variations in the vertical-plane antenna pattern as well as the variation in straight-line distance to the antenna.

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. In any case, the RF levels more than 500 feet from a wireless antenna site are well understood to be sufficiently low to be comfortably in compliance.

According to the FCC, when directional antennas (such as panels) are used, compliance assessments are based on the RF effect of a single (facing) antenna sector, as the effects of directional antennas pointed away from the point(s) of

interest are considered insignificant. If the different parameters apply in the different sectors, compliance is based on the worst-case parameters.

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

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

1. The antennas are assumed to be operating continuously at maximum power and maximum channel capacity.
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 assuming a 6'6" human and performing the calculations from the bottom (rather than the centerline) of each operator's lowest-mounted antenna, as applicable.
4. The calculations also conservatively take into account, when applicable, the different technical characteristics and related RF effects of the use of multiple antennas for transmission in the same frequency band.
5. The RF exposure at ground level is assumed to be 100-percent enhanced (increased) via a "perfect" field reflection from the intervening ground.

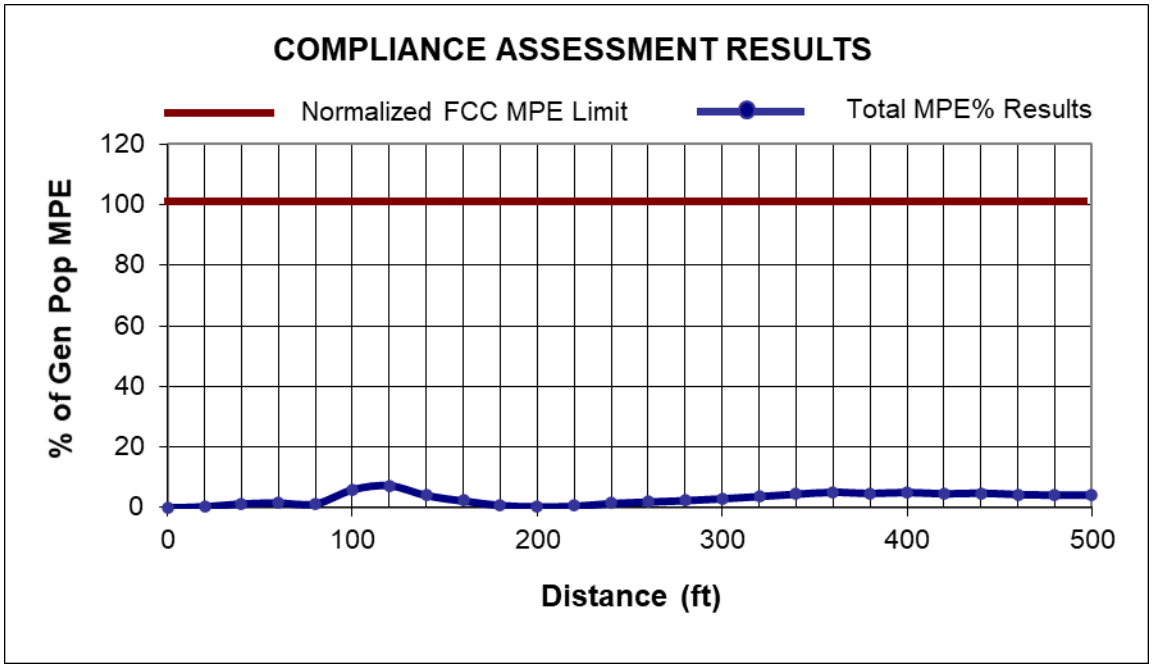
The net result of these assumptions is to intentionally and significantly overstate the calculated RF levels relative to the levels that will actually result from the antenna operations – and the purpose of this conservatism is to allow very "safe-side" conclusions about compliance.

The table that follows provides the results of the MPE% calculations for each antenna operation, with the worst-case overall result highlighted in bold in the last column.

Ground Distance (ft)	AT&T 600 MHz MPE%	AT&T 700 MHz MPE%	AT&T 1900 MHz MPE%	AT&T 2100 MHz MPE%	AT&T 2300 MHz MPE%	T-Mobile MPE%	Total MPE%
0	0.0693	0.0325	0.0023	0.0021	0.0071	0.0083	0.1216
20	0.2009	0.1904	0.0003	0.0007	0.0203	0.0281	0.4407
40	0.9021	0.2055	0.0125	0.0060	0.0419	0.2086	1.3766
60	0.7403	0.4237	0.0815	0.0626	0.0752	0.2038	1.5871
80	0.0142	0.0677	0.5959	0.0109	0.1082	0.5449	1.3418
100	0.8337	0.1980	2.2027	1.3364	0.1520	1.0855	5.8083
120	2.0624	0.9593	0.6358	1.4299	1.5212	0.4777	**7.0863**
140	2.0985	1.0777	0.0147	0.0873	0.5318	0.1491	3.9591
160	1.2789	0.6244	0.1009	0.0691	0.0032	0.1745	2.2510
180	0.3826	0.1397	0.0950	0.0564	0.0442	0.1187	0.8366
200	0.1194	0.0047	0.1119	0.0554	0.0057	0.1139	0.4110
220	0.1555	0.0345	0.0833	0.0799	0.0159	0.2295	0.5986
240	0.6106	0.2960	0.0157	0.0858	0.0878	0.3878	1.4837
260	0.9422	0.4816	0.0200	0.0458	0.0851	0.3444	1.9191
280	1.3229	0.6841	0.0683	0.0217	0.0504	0.2389	2.3863
300	1.7237	0.8893	0.1424	0.0490	0.0130	0.1387	2.9561
320	2.1311	1.0819	0.2049	0.1269	0.0083	0.1052	3.6583
340	2.5213	1.2538	0.2175	0.2087	0.0454	0.1644	4.4111
360	2.8789	1.3990	0.1660	0.2313	0.0942	0.2401	5.0095
380	2.5952	1.2612	0.1497	0.2085	0.0849	0.3348	4.6343
400	2.8857	1.3704	0.0692	0.1507	0.0975	0.3899	4.9634
420	2.6260	1.2471	0.0630	0.1372	0.0887	0.3577	4.5197
440	2.8584	1.3265	0.0075	0.0463	0.0562	0.4482	4.7431
460	2.6217	1.2167	0.0069	0.0425	0.0516	0.3535	4.2929
480	2.4131	1.1199	0.0063	0.0391	0.0475	0.4776	4.1035
500	2.5701	1.1656	0.0251	0.0002	0.0103	0.3881	4.1594

As indicated, the maximum calculated overall RF level is 7.0863 percent of the FCC MPE limit – well below the 100-percent reference for compliance.

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



Compliance Conclusion

According to the FCC, the MPE limit has been constructed in such a manner that continuous human exposure to RF fields up to and including 100 percent of the MPE limit is acceptable and safe.

The conservative analysis in this case shows that the maximum calculated RF level from the combination of proposed and existing for antenna operations at the site is 7.0863 percent of the FCC general population MPE limit. In other words, the worst-case calculated RF level is more than 10 times below the FCC MPE limit (and, correspondingly, more than 50 times below the related MPE limit in the *New*

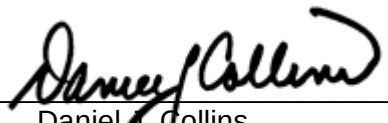
Jersey Radiation Protection Act).

The results of the calculations indicate clear compliance with the FCC MPE regulations, as well as with that of the State of New Jersey. Moreover, because of the extremely conservative calculation methodology and operational assumptions we applied in the analysis, RF levels actually caused by the antennas will be significantly lower than the calculation results here indicate.

Certification

It is the policy of Pinnacle Telecom Group that all FCC RF compliance assessments are reviewed, approved, and signed by the firm's Chief Technical Officer who 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 concerning the control of potential human exposure to the RF emissions from antennas.



2/19/21

Daniel J. Collins
Chief Technical Officer
Pinnacle Telecom Group, LLC

Date

Appendix A. The FCC and State of New Jersey MPE Limits

FCC Rules and Regulations

As directed by the Telecommunications Act of 1996, the FCC has established limits for maximum continuous human exposure to RF fields.

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.

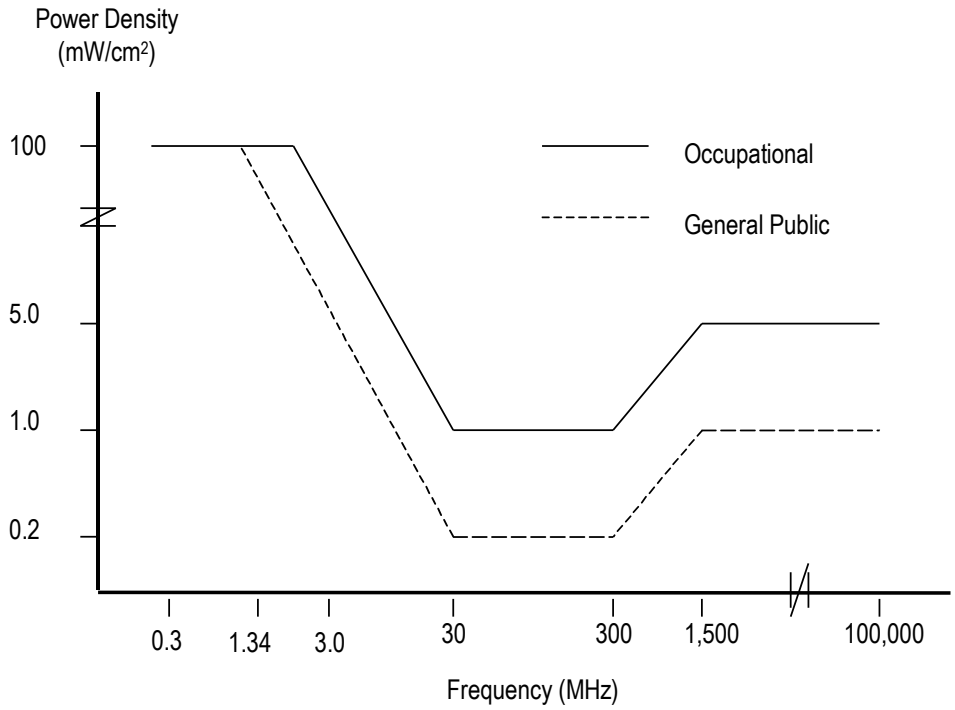
The specified continuous exposure MPE limits are based on known variation of human body susceptibility in different frequency ranges, and a Specific Absorption Rate (SAR) of 4 watts per kilogram, which is universally considered to accurately represent human capacity to dissipate incident RF energy (in 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 RF exposure 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.

New Jersey's Radiation Protection Act

The State of New Jersey's *Radiation Protection Act* (N.J.S.A 26:2D *et seq*) includes virtually identical language to the FCC's regulations regarding potential human exposure to RF fields.

There is, however, one critical difference between the respective MPE limits described in each source. While the FCC describes two tiers of MPE limits – one for "uncontrolled" exposure of the general population, and one five times less strict for "controlled" occupational exposure – the New Jersey Radiation Protection Act only describes one limit, applicable to all circumstances, and that limit is identical to the FCC's "controlled" occupational exposure.

Therefore, since the limit chosen in New Jersey matches the FCC's occupational limit but applies to exposure of the general public as well, the New Jersey limit is less protective of the general public by a factor of five, relative to the FCC's limit for the general public.

Appendix B. 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 Report and Order, Notice of Proposed Rulemaking, Memorandum Opinion and Order (FCC 19-126), *Proposed Changes in the Commission's Rules Regarding Human Exposure to Radiofrequency Electromagnetic Fields; Reassessment of Federal Communications Commission Radiofrequency Exposure Limits and Policies,* released December 4, 2019.

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.

“RF Field Measurements for Antenna Sites”, (video), Richard Tell Associates Inc., 1997.

“EME Awareness for Antenna Site Safety”, (video), Motorola (produced in association with Richard Tell Associates Inc.), 1997.

Appendix C. Summary of Expert Qualifications

Daniel J. Collins, Chief Technical Officer, Pinnacle Telecom Group, LLC

Synopsis:	• 40+ years of experience in all aspects of wireless system engineering, related regulation, and RF exposure • Has performed or led RF exposure compliance assessments on more than 20,000 antenna sites since the latest FCC regulations went into effect in 1997 • Has provided testimony as an RF compliance expert more than 1,500 times since 1997 • Have been accepted as an FCC compliance expert in New Jersey, New York, Connecticut, Pennsylvania and more than 40 other states, as well as by the FCC
Education:	• B.E.E., City College of New York (Sch. Of Eng.), 1971 • M.B.A., 1982, Fairleigh Dickinson University, 1982 • Bronx High School of Science, 1966
Current Responsibilities:	• Leads all PTG staff work involving RF safety and FCC compliance, microwave and satellite system engineering, and consulting on wireless technology and regulation
Prior Experience:	• Edwards & Kelcey, VP – RF Engineering and Chief Information Technology Officer, 1996-99 • Bellcore (a Bell Labs offshoot after AT&T's 1984 divestiture), Executive Director – Regulation and Public Policy, 1983-96 • AT&T (Corp. HQ), Division Manager – RF Engineering, and Director – Radio Spectrum Management, 1977-83 • AT&T Long Lines, Group Supervisor – Microwave Radio System Design, 1972-77
Specific RF Safety / Compliance Experience:	• Involved in RF exposure matters since 1972 • Have had lead corporate responsibility for RF safety and compliance at AT&T, Bellcore, Edwards & Kelcey, and PTG • While at AT&T, helped develop the mathematical models for calculating RF exposure levels • Have been relied on for compliance by all major wireless carriers, as well as by the federal government, several state and local governments, equipment manufacturers, system integrators, and other consulting / engineering firms
Other Background:	• Author, *Microwave System Engineering* (AT&T, 1974) • Co-author and executive editor, *A Guide to New Technologies and Services* (Bellcore, 1993) • National Spectrum Management Association (NSMA) – former three-term President and Chairman of the Board of Directors; was founding member, twice-elected Vice President, long-time member of the Board, and was named an NSMA Fellow in 1991 • Have published more than 35 articles in industry magazines