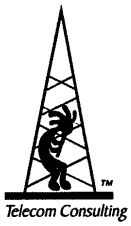


Pinnacle Telecom Group

Professional and Technical Services

WiFi RF Measurements and Compliance with the FCC RF Safety Limit

Ridgewood Public Schools

April 14, 2015

14 Ridgedale Avenue - Suite 209 • Cedar Knolls, NJ 07927 • 973-451-1630

Contents

Introduction and Summary

On April 9, 2015, at the request of the Ridgewood Public Schools District Information Technology (IT) Department, Pinnacle Telecom Group visited the Somerville Elementary School and Ridgewood High School to perform on-site measurements of the radiofrequency (RF) levels associated with WiFi transmissions inside the schools. Escort was provided by Ryan Kenny, District Manager of the IT Department, and the two schools were selected as representative of the two different types of WiFi operations in the school district.

The purpose of the measurements was to provide an assessment of the potential RF exposure levels relative to the limit in the regulations of the Federal Communications Commission (FCC) for safe, continuous human exposure to the RF emissions from antennas. That limit is referred to as the FCC general population "maximum permissible exposure" (MPE) limit, and is described in Appendix A. According to the FCC, the MPE limit represents appropriate RF protection for humans of either sex, all ages, all sizes, and under all conditions, and continuous human exposure to RF levels up to an including 100 percent of the limit is safe and carries no health risk.

The results of a compliance assessment such as this can most clearly be explained by describing the measured RF levels as simple percentages of the FCC MPE limit. If the reference for that limit is 100 percent, then RF levels higher than 100 percent indicate the MPE limit is exceeded, while RF levels lower than 100 percent indicate compliance with the limit.

The results of the measurements are as follows:

- ***Somerville Elementary School:*** The measured RF levels ranged from 0.1 percent to 1.0 percent of the FCC general population MPE limit; in other words, the maximum measured RF level inside the school was 100 times below the FCC limit.
- ***Ridgewood High School:*** The measured RF levels ranged from 0.05 percent to 0.5 percent of the FCC general population MPE limit; in other

words, the maximum measured RF level inside the school was 200 times below the FCC limit.

The results of the measurements show that the RF levels resulting from the WiFi operations inside the schools are in clear compliance with the FCC limit for safe, continuous human exposure to RF emissions from antennas. This is not an unexpected result, given the WiFi units have a transmitter power of no more than 40 milliwatts, or 0.04 watt.

The remainder of this report provides details of the on-site visits and measurements. In addition, Appendices A and B provide photographs taken at each of the two schools, Appendix C provides background on the FCC limits for RF exposure, along with a list of FCC references. Appendix D provides a description of the measurement equipment and procedure. Appendix E provides a summary of the expert qualifications of the author of this report.

Somerville Elementary School

The Somerville Elementary School is located at 45 South Pleasant Avenue in Ridgewood. There are ceiling mounted and wall-mounted WiFi units (Maru AP320) in various areas inside the building. Photographs of the areas visited are provided in Appendix A. The school principal, Lorna Oates-Santos, observed the measurements along with Mr. Kenny.

In each of the areas described below, RF measurements were made as close as one could get to each WiFi unit, as well as throughout the rest of the room. The maximum measured RF levels, each expressed as a percentage of the FCC general population MPE limit ("Max. MPE%"), are provided in the table that follows.

Location	Max. MPE%
Principal's Office	0.25%
CST Office (no WiFi)	0.10%
2nd Floor Computer Lab	0.10%
Room 210 - Classroom	0.15%
2nd Floor Resource Center	1.00%
Room 119 - Classroom	0.50%
Room 101 Classroom	1.00%

As can be seen in the table, the maximum measured RF level in any of the areas inside the school is 1.0 percent of the FCC general population MPE limit. In other words, the worst-case measured RF level is 100 times below the FCC limit.

Measurements were also performed outside the school, and a maximum of 2.5 percent was found on South Mount Pleasant Avenue in front of the school and under a transformer on a utility pole. (Based on our experience, this is not an uncommon result. Note that everything that operates with electricity naturally and unavoidably emits some low level of RF energy, and the FCC recognizes this under a category called "incidental radiators".)

Ridgewood High School

Ridgewood High School is located at 627 East Ridgewood Avenue in Ridgewood. There are ceiling mounted and wall-mounted WiFi units (Maru AP832) in various areas inside the building. Photographs of the areas visited are provided in Appendix B.

In each of the areas described below, RF measurements were made as close as one could get to each WiFi unit, as well as throughout the rest of the room. The maximum measured RF levels, each expressed as a percentage of the FCC general population MPE limit are provided in the table on the next page.

Location	Max. MPE%
Principal's Office	0.05%
Campus Center	0.10%
Learning Commons	0.10%
Tech Office – Room 237	0.30%
MDF – Server Room	0.20%
Room 204 - Classroom	0.50%

As can be seen in the table, the maximum measured RF level in any of the areas inside the high school was 0.5 percent of the FCC general population MPE limit. In other words, the worst-case measured RF level in this case is 200 times below the FCC limit. Measurements were also performed outside the school, and a maximum of 0.5 percent was found on East Ridgewood Avenue in front of the school.

Compliance Conclusion

The results of the measurements inside the two schools provide a clear demonstration that the RF levels from the WiFi units are in compliance with the FCC general population MPE limit. The maximum measured RF level inside either of the schools was 1.0 percent of the FCC limit – that is, 100 times below the limit.

It may also be useful to put that 1.0-percent maximum measured result in this case into an everyday layman perspective via comparisons to other common exposure situations. Consider the following:

- Measurements we have performed inside hundreds of residences (both private homes and apartments) across the country show the ambient RF energy levels to consistently be in the range of 0.5 percent of the FCC limit to as much as 7.0 percent, owing primarily to the RF energy emitted on an incidental ("leakage") basis by common household electric appliances and consumer electronics. These results are independent of any outdoor antenna

operations in the vicinity; the “before-and-after” measurements we have done show the same results.

- Measurements have been performed by the US National Institute of Science and Technology (part of the Commerce Department) in the 50 largest US metropolitan cities. The results showed ambient street-level exposure averages 1.6 percent of the FCC limit – with *or without antennas in the immediate vicinity*, which is a clear indication that the primary sources of interest are the remote-but-high-power broadcast transmitters and the “RF leakage” from electronic and electric devices in the immediate vicinity. Similar PTG measurements in smaller cities (e.g., Livingston, NJ) indicate an average exposure of about one percent of the limit, and in larger cities (Newark, NJ and New York City) the ambient RF levels average close to two percent.

One last point of possible interest: human beings, recognized by physicists as “black body radiators”, naturally emit a low level of RF energy, equivalent to approximately 0.15 percent of the FCC general population MPE limit. That falls within the 0.1- to 1.0-percent range of the measurement results inside the two schools, and beyond the simple demonstration of compliance, it may also serve as a demonstration that the RF levels from the WiFi operations are acceptably low.

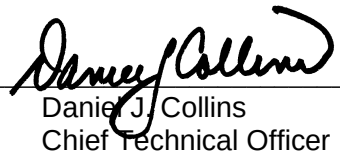
Certification

The undersigned hereby 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. The equipment used to perform the RF measurements described herein is appropriate to the task, and calibration of its accuracy has been performed within the past 12 months as recommended by the manufacturer.
3. The on-site RF measurements described herein were performed in a manner consistent with industry standards.
4. To the best of my knowledge, the statements and information disclosed in

this report are true, complete and accurate.

5. The analysis of RF compliance provided herein is consistent with the applicable FCC regulations, additional guidelines issued by the FCC, and industry practice.



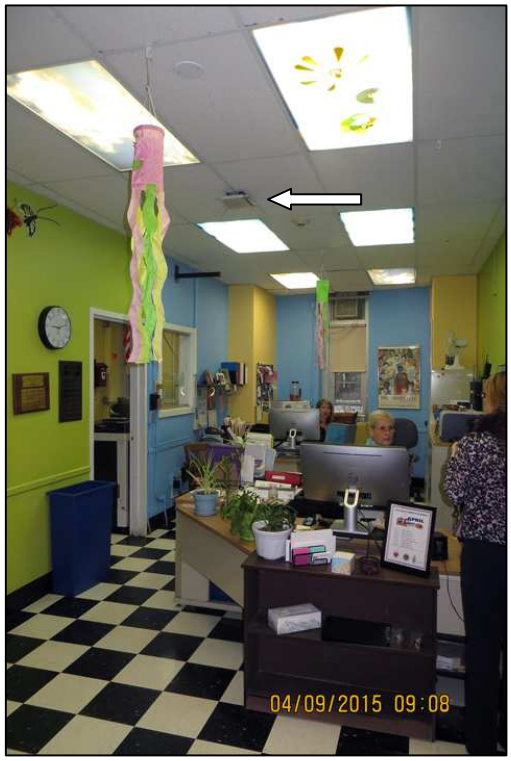
4/14/15

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

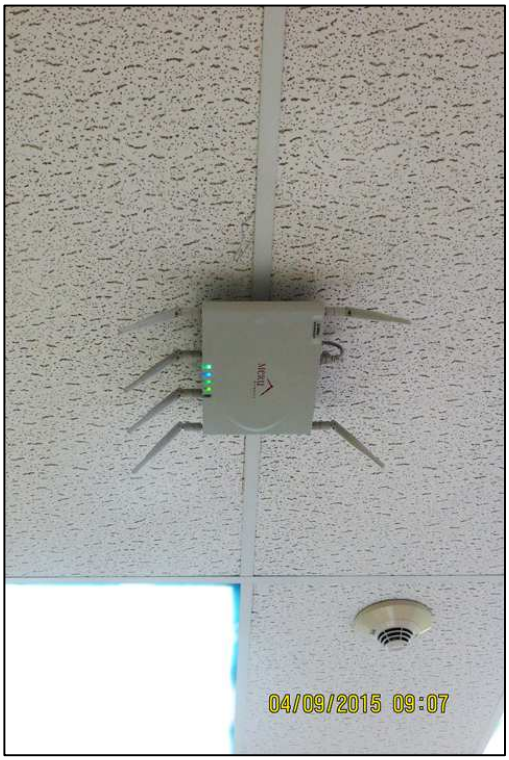
Date

Appendix A. Photographs – Somerville Elementary School

View of school from South Pleasant Avenue



Principal's Office – antenna on ceiling (arrow)



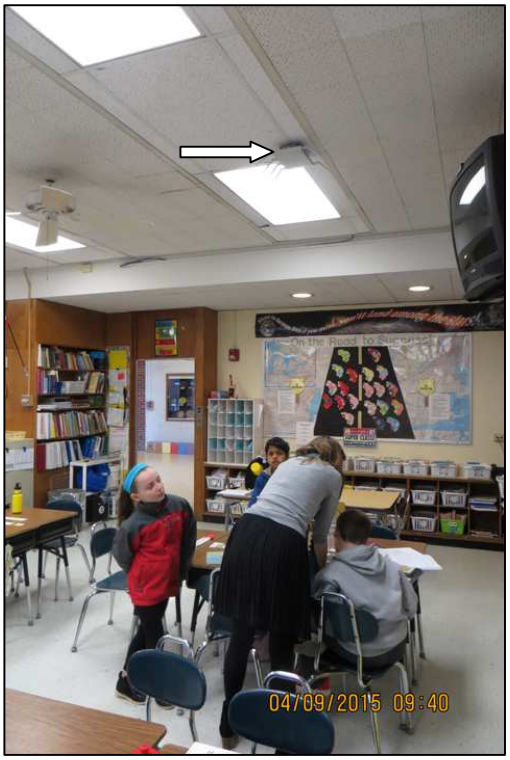
Principal's Office – close-up of antenna

CST Office (no antennas)

2nd Floor Computer Lab (no antennas)

Room 210 – Classroom (arrow points to antenna)

2nd Floor Resource Center (arrow points to antenna)



Room 119 - Classroom (arrow points to antenna)

Room 101 - Classroom (arrow points to antenna)

Power line transformer on utility pole in front of school

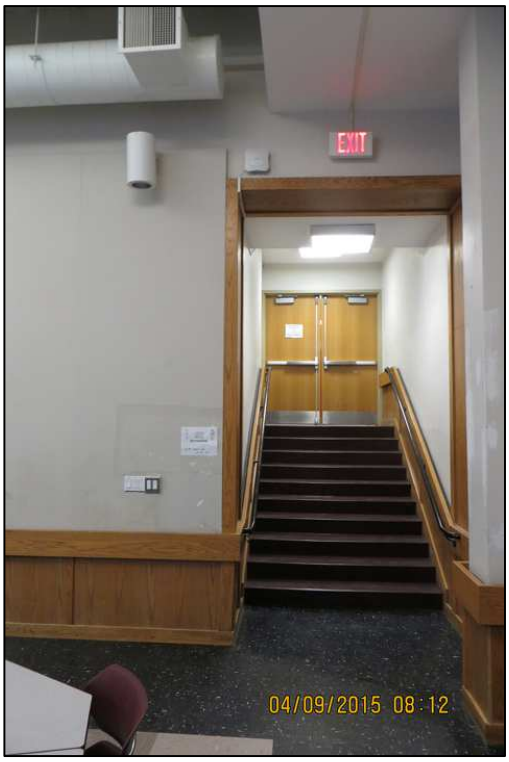
Appendix B. Photographs – Ridgewood High School

View of High School from street

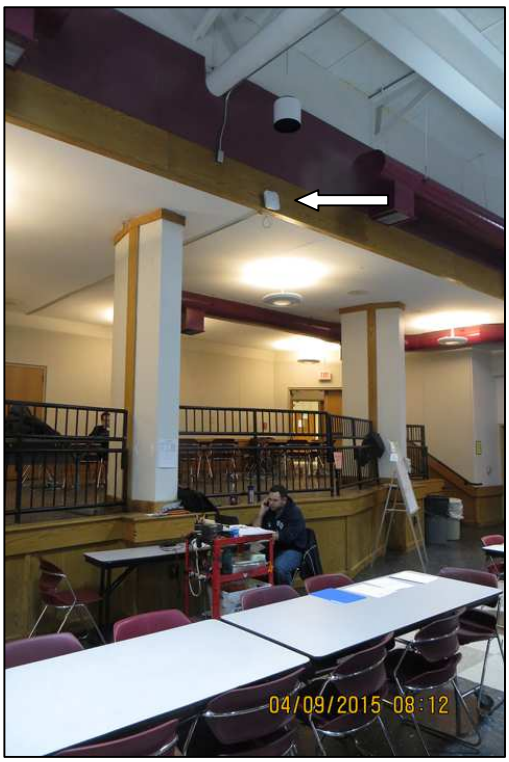
Principal's Office – antenna above door

Principal's Office – close-up of antenna

Campus Center

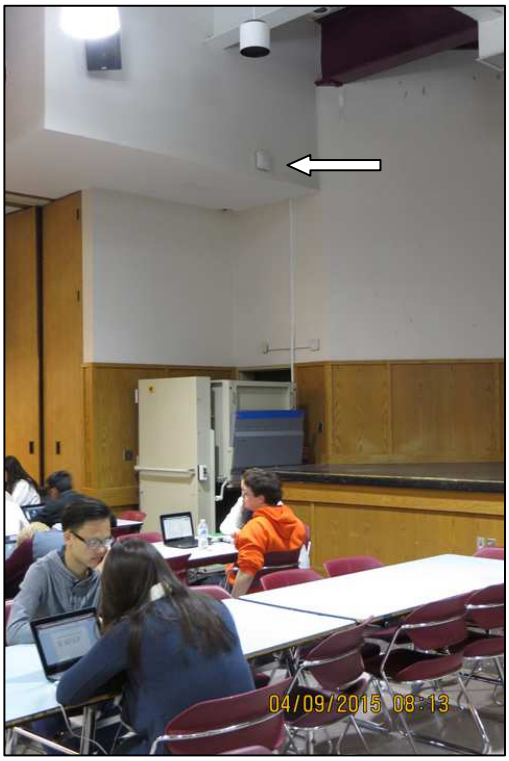


Campus Center – antenna above door (1st of 4)



Campus Center – 2nd (arrow) of 4

Campus Center – 3rd (arrow) of 4

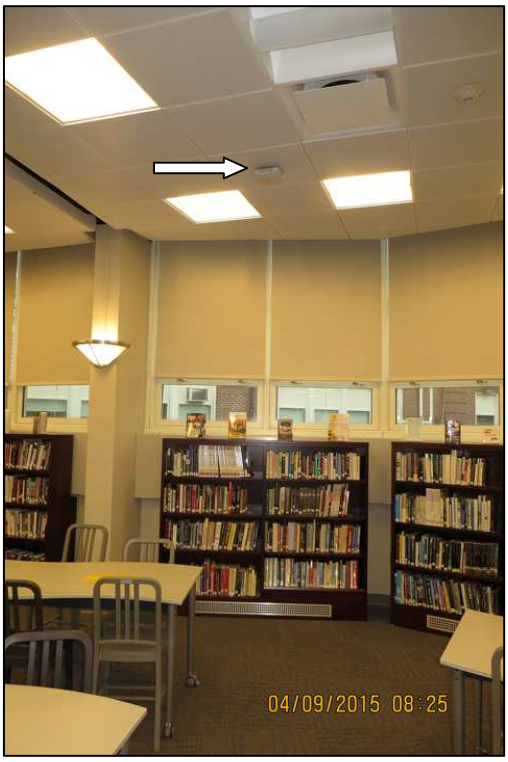


Campus Center – 4th (arrow) of 4

Learning Commons

Photo showing meter and measurement in Campus Center

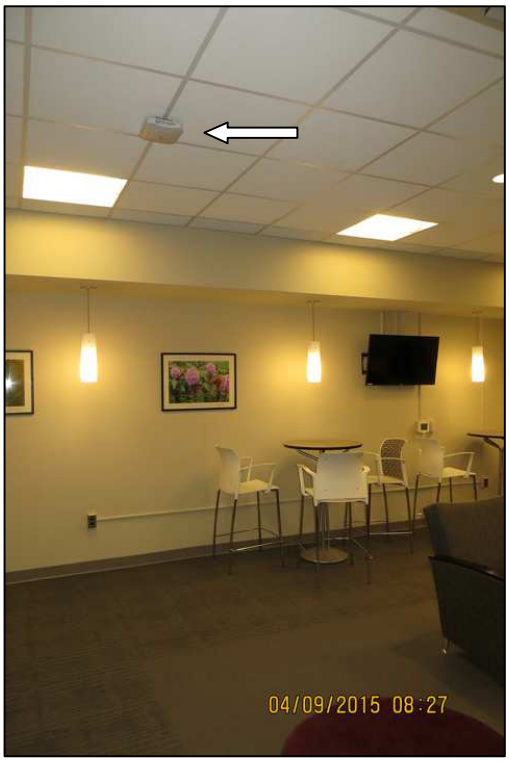
Learning Commons



Learning Commons – 1st of 4 (arrow)

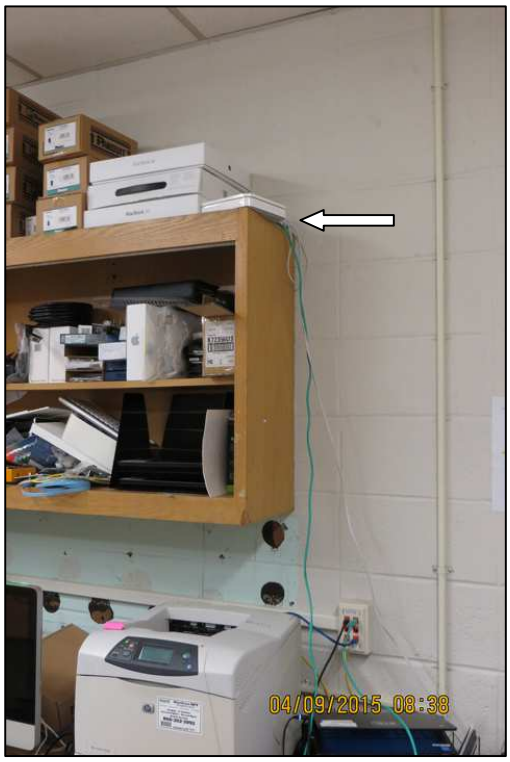
Learning Commons – 2nd of 4 (arrow)

Learning Commons – 3rd of 4 (arrow)



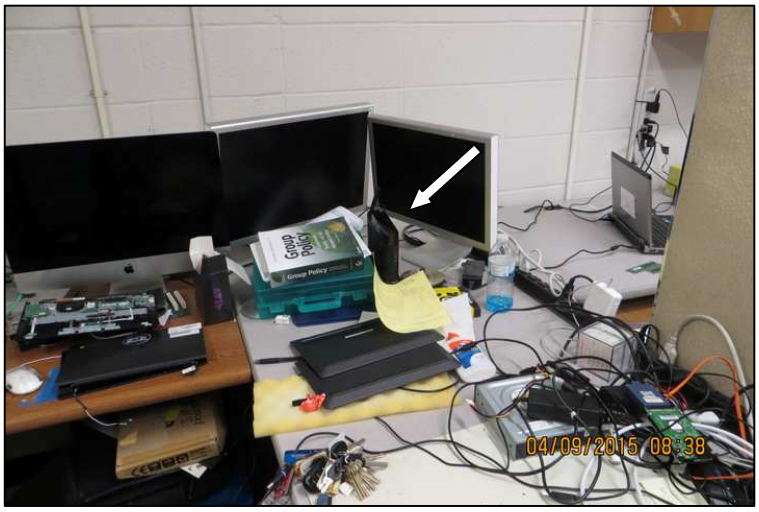
Learning Commons – 4th of 4 (arrow)

Tech Office – Room 237



Tech Office - 1st of 2 (arrow)

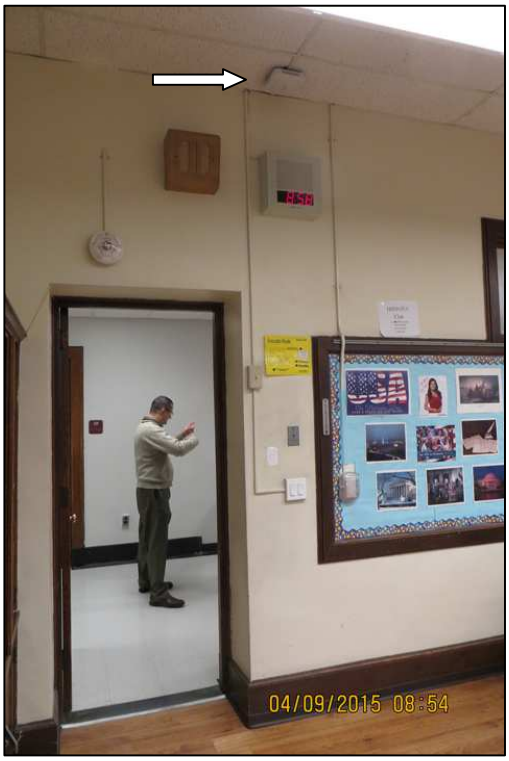
Tech Office – 2nd of 2 (arrow)



Tech Office – cell phone signal booster (arrow)

MDF – Server Room (no antennas)

Room 204 – Classroom



Room 204 – Classroom (antenna on ceiling)

Appendix C. Background on the FCC MPE Limit

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

The FCC maximum permissible exposure (MPE) limit 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.

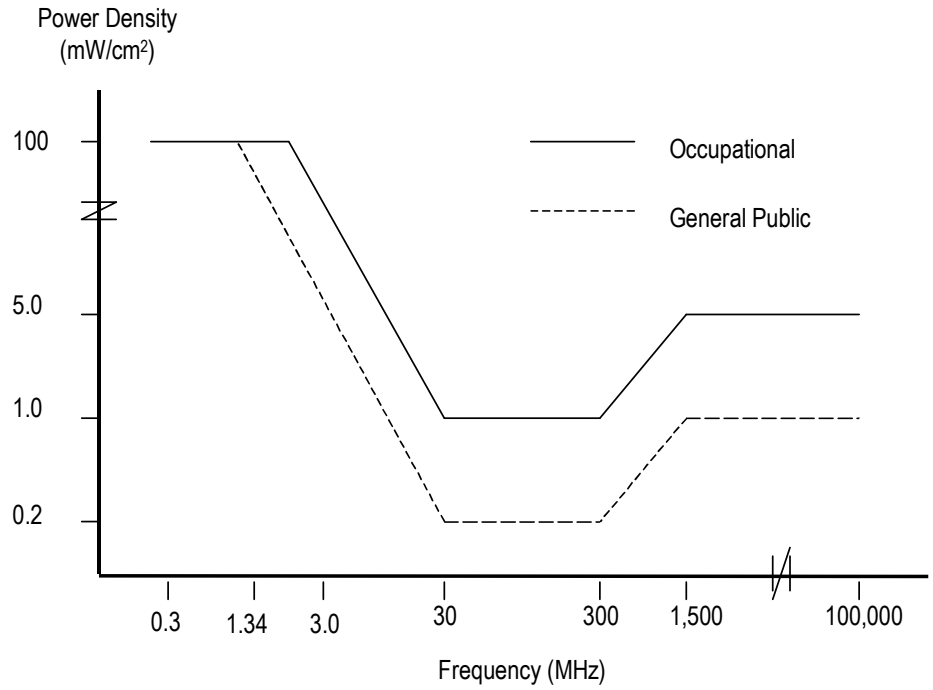
The specified continuous exposure MPE limits are based on known variation of human body susceptibility in different frequency ranges, and a Specific Absorption Rate (SAR) of 4 watts per kilogram, which is universally considered to accurately represent human capacity to dissipate incident RF energy (in 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. Continuous exposure at levels equal to or below the applicable MPE limits is considered to result in no adverse health effects on humans.

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.

References on FCC 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.

“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 D. Measurement Equipment and Procedure

RF measurements were performed using a Narda model EA5091 RF probe and Narda model NBM-520 RF meter. Both the probe and meter are capable of broadband RF measurements, covering a range of 300 kHz to 50 GHz.

The measuring equipment is designed to automatically register all RF levels from all RF sources within the frequency range and report them as percentages of the FCC's overall occupational MPE limit. Converting the measurement result to reference the general population MPE limit is simply a matter of multiplying the readout by five.

The equipment was calibrated by the manufacturer within the past 12 months.

The measurements were taken in a manner consistent with training provided by the equipment manufacturer, including the “RF Field Measurements for Antenna Sites” videotape, developed by Richard Tell Associates and now included as part of the Narda equipment package.

In order to ensure "safe-side" results, maximum RF spot-levels were measured and reported in all areas.

Appendix E. 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 17,000 antenna sites since the FCC rules went into effect in 1997 • Has provided testimony as an RF compliance expert more than 1,400 times since 1997 • Accepted as an expert in New York, New Jersey, 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, Executive Director – Regulation and Public Policy, 1983-96 • AT&T (Corp. HQ), Director – Spectrum Management Policy and Practice, 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 • 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 Managers Association (NSMA) – former three-term President and Chairman of the Board of Directors; was founding member, twice-elected Vice President, a long-time member of the Board of Directors, and was named an NSMA Fellow in 1991 • Published more than 35 articles in industry magazines