



RADIO FREQUENCY EMISSIONS ANALYSIS REPORT
EVALUATION OF HUMAN EXPOSURE POTENTIAL
TO NON-IONIZING EMISSIONS

Lighttower Utility Pole Antenna Installation

Lighttower Project ID: SC-NY 0227

Lighttower Small Cell Name:
Node: Washington Street & Vestry Street

New York, NY

November 13, 2017

Centerline Project Number: 950002-015

Site Compliance Summary	
Compliance Status:	Compliant
Maximum Sector total MPE% of FCC general population allowable limit at ground level:	0.12%



November 13, 2017

Lighttower
Attn: Scott Mallon
Regional Operations Manager - Wireless
Northeast Region

Emissions Analysis for Utility Pole Antenna Installation: **SC-NY 0227**

Centerline Communications was directed to analyze the proposed Lighttower utility pole antenna installation for the purpose of determining whether the emissions from the proposed utility pole antenna installations are within specified federal limits with regards to radio frequency emissions. Table 1 below contains location data regarding each antenna location.

Lighttower Node ID	Latitude	Longitude	Location Description
SC-NY 0227	40.722834	-74.010570	Corner of Washington Street & Vestry Street, New York, NY

Table 1: Antenna Location Data



All information used in this report was analyzed as a percentage of current Maximum Permissible Exposure (% MPE) as listed in the FCC OET Bulletin 65 Edition 97-01 and ANSI/IEEE Std C95.1. The FCC regulates Maximum Permissible Exposure in units of microwatts per square centimeter ($\mu\text{W}/\text{cm}^2$). The number of $\mu\text{W}/\text{cm}^2$ calculated at each sample point is called the power density. The exposure limit for power density varies depending upon the frequencies being utilized. Wireless Carriers and Paging Services use different frequency bands each with different exposure limits, therefore it is necessary to report results and limits in terms of percent MPE rather than power density.

All results were compared to the FCC (Federal Communications Commission) radio frequency exposure rules, 47 CFR 1.1307(b)(1) – (b)(3), to determine compliance with the Maximum Permissible Exposure (MPE) limits for General Population/Uncontrolled environments as defined below.

General population/uncontrolled exposure limits apply to situations in which the general population may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Therefore, members of the general population would always be considered under this category when exposure is not employment related, for example, in the case of a telecommunications tower that exposes persons in a nearby residential area.

Population exposure to radio frequencies is regulated and enforced in units of microwatts per square centimeter ($\mu\text{W}/\text{cm}^2$). The general population exposure limit is $1000 \mu\text{W}/\text{cm}^2$ at 1900 MHz.

Occupational/controlled exposure limits apply to situations in which persons are exposed as a consequence of their employment and in which those persons who are exposed have been made fully aware of the potential for exposure and can exercise control over their exposure. Occupational/controlled exposure limits also apply where exposure is of a transient nature as a result of incidental passage through a location where exposure levels may be above general population/uncontrolled limits (see below), as long as the exposed person has been made fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

Additional details can be found in FCC OET 65.



CALCULATIONS

Calculations were done for proposed utility pole antenna installations shown in Table 1 utilizing the equipment listed below. All calculations were performed per the specifications under FCC OET 65. Lightower is proposing **Antenna Products (Phazar) 0-6002V-Z4-F4T** omnidirectional antenna. All calculations were performed utilizing actual antenna gain values per the antenna manufactures supplied specifications for greater accuracy. All values calculated to provide a spatial maximum value over a 6-foot vertical column along a radial extending out 500 feet from the base of the antenna location at the ground level. At the antenna centerline height, the spatial maximum power density values were calculated for the antenna height alone to yield the highest potential values at this height due to proximity to the antenna face. Spatial maximum includes the maximum value calculated at any point over the specified 6-foot column

For all calculations, all equipment was calculated using the following assumptions:

- 1) One (1) Alcatel Lucent CMRO Remote Radio Unit (RRU) operating at 1900 MHz. This RRU will be operated in MIMO configuration utilizing two (2) 5 Watt transmit streams. The maximum deployed composite transmit power specified for these Remote Radio Heads is 10 Watts.
- 2) All radios at the proposed installation were considered to be running at full power in their RF transmissions paths per carrier prescribed configuration and listed in the attached data sheets. Per FCC OET Bulletin No. 65 - Edition 97-01 recommendations to achieve the maximum anticipated value at each sample point, all power levels emitting from the proposed antenna installation were calculated utilizing Equation 9 of the FCC's OET Bulletin No. 65 to assume for a worst case prediction.
- 3) All values calculated for a spatial maximum value over a 6-foot vertical column along a radial extending out 500 feet from the base of the antenna location at the ground level. At the antenna centerline height, the spatial maximum power density value was calculated for a radial at the antenna height to demonstrate the highest potential at that level. Spatial maximum includes the maximum value calculated at any point over the specified 6-foot column.



- 4) The antenna used in this modeling is the **Antenna Products (Phazar) 0-6002V-Z4-F4T** antenna for transmission in the 1900 MHz (PCS) frequency bands. This is based on feedback from Lighttower with regards to anticipated antenna selection. The **Antenna Products (Phazar) 0-6002V-Z4-F4T** antenna has a maximum gain of **5.1 dBi** at its main lobe at 1900 MHz. All ground level values were calculated as a spatial maximum value over a 6-foot column at ground along a radial extending out 500 feet from the base of the antenna location. At the antenna centerline height, the spatial maximum power density values were calculated for the antenna height alone to yield the highest potential values at this height due to proximity to the antenna face. Spatial maximum includes the maximum value calculated at any point over the specified 6-foot column.
- 5) The antenna mounting height for the proposed utility pole antenna installations are **30 feet above ground level** to antenna centerline.
- 6) All calculations were done with respect to uncontrolled / general population and controlled / occupational threshold limits as specified in FCC OET65.



Lighttower Antenna Configuration Data Table

Lighttower ID	Latitude	Longitude	Antenna Centerline (feet)	Frequency Bands	Radio Models	Antenna Make	Antenna Model	Azimuth (degrees)	EiRP (Watts)
SC-NY 0227	40.722834	-74.010570	30	1900 MHz	Alcatel Lucent RRU	Antenna Products (Phazar)	0-6002V-Z4-F47	Omni	32.36 Watts EiRP

Table 2: Lighttower Antenna Configuration Data Table



RESULTS

The following calculation results data sheets provide an overview regarding the location, configuration and emissions values, both composite and for each individual frequency band, as well as compliance status for each location based upon the FCC's allowable limits for general population (uncontrolled) and occupational (controlled) exposure to radio frequency emissions. Each data sheet has an associated graph showing the emissions values at given distances from the antenna location along the pointing direction of each antenna at the site. The data in the graphs is shown both for each individual frequency band as a composite value.

As seen in the following data sheets, there are no areas along the ground level that exceed the FCC's allowable limits for general population (uncontrolled) and occupational (controlled) exposure to radio frequency emissions.

At the antenna centerline level, there is an area that extends up to **2 feet** from the antenna face that may exceed the FCC's allowable limit for occupational (controlled) exposure to radio frequency emissions. Additionally, at the antenna centerline level there is an area that extends approximately **3 feet** from the antenna face that may exceed the FCC's allowable limit for general population (uncontrolled) exposure to radio frequency emissions.

Moving vertically from the ground level up through the antenna mounting height, the area that exceeds the FCC's allowable limit for occupational (controlled) exposure to radio frequency emissions, within the specified 2-foot horizontal zone from the antenna face, runs from approximately **27 feet above ground level to 33 feet above ground level**. Additionally, the area that exceeds the FCC's allowable limit for general population (uncontrolled) exposure to radio frequency emissions, within the specified 10-foot horizontal zone from the antenna face, runs from approximately **26 feet above ground level to 34 feet above ground level**. Table 3 contains a summary of these results.

Table 4 below shows the recommended signage to ensure the proposed facility is in compliance with all federal requirements regarding emissions compliance and notification standards.



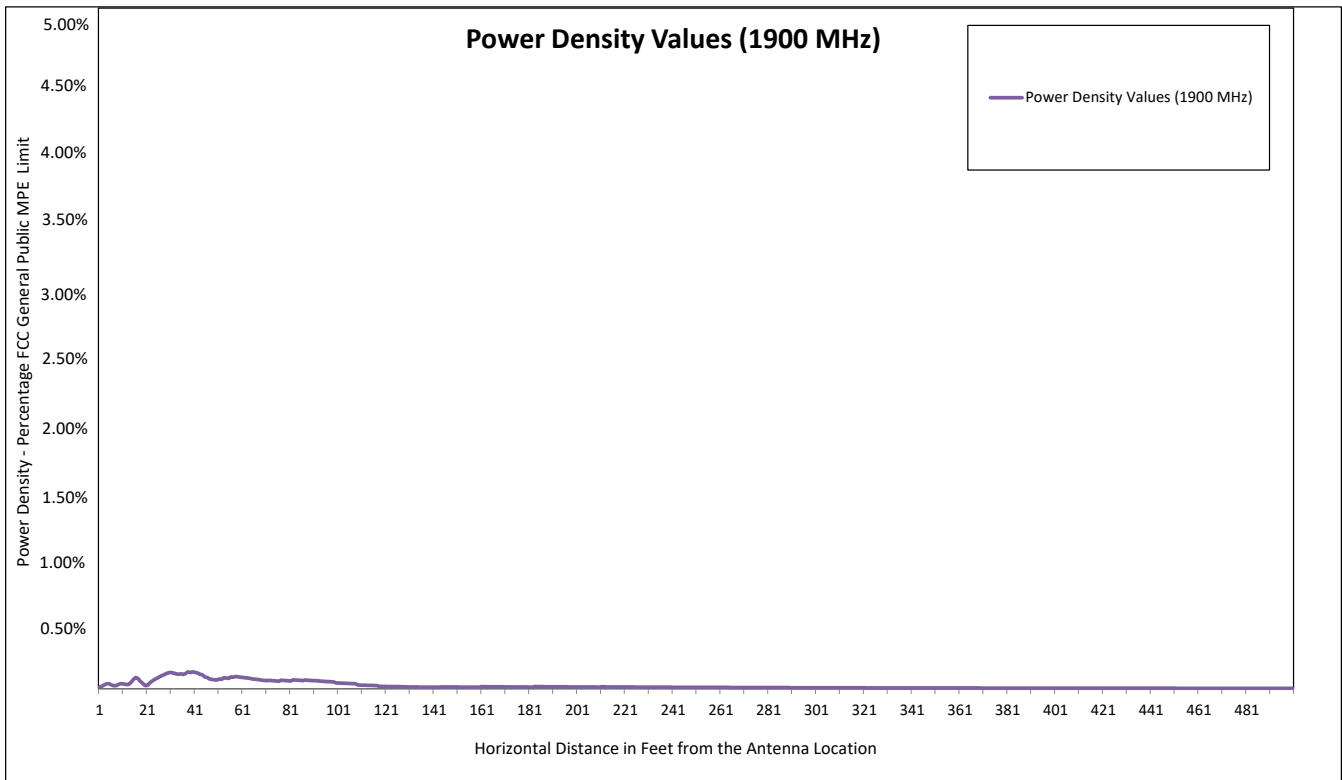
Lighttower Antenna Location Compliance Results

Lighttower ID	Total EiRP (Watts)	Ground Level General Population Limit Exceedence Distance (ft)	Ground Level Occupational Limit Exceedence Distance (ft)	Antenna Level General Population Limit Exceedence area Distance (ft)	Antenna Level Occupational Limit Exceedence area Distance (ft)	Vertical General Population Limit Exceedence area Height Above Ground (ft)	Vertical Occupational Limit Exceedence area Height Above Ground (ft)	Compliance Recommendations
SC-NY 0227	32.36 Watts	No Exceedence	No Exceedence	3 feet	2 feet	26 feet	27 feet	Signage

Table 3: Lighttower Antenna Location Compliance Results

Antenna Location Data For Location:				SC-NY 0227	
Location Number:	SC-NY 0227	Antenna Make:	Antenna Products	Equipment Manufacturer:	Alcatel Lucent
Latitude (N):	40.722834	Antenna Model:	0-6002V-Z4-F4T	Equipment Model:	CMRO
Longitude (W):	-74.01057	Antenna Azimuth (Degrees):	Omni	Number of Antennas at Location:	1
Emissions Compliance:	Compliant	Antenna Height (ft):	30.00	Analysis Location (6 foot person):	Ground Level
Total TX Power_ 1900 MHz (Watts):	10	Maximum Power Density at 1900 MHz (% MPE)	0.12%	Distance From Antenna To Maximum Power Density Location at 1900 MHz (feet):	40
Cable Loss (dB):	0	Splitter / Combiner Loss (dB):	0	Additional System Gains (dB):	0
Distance from antenna face that exceeds the FCC's Occupational Threshold for Radio Frequency Emissions - 6 spatial max Values (feet):			No Exceedences		
Distance from antenna face that exceeds the FCC's General Public Threshold for Radio Frequency Emissions - 6 footspatial max Values (feet):			No Exceedences		
Total Site EIRP (Watts):	32.36	Maximum Composite Power Density for all Frequency Bands (% MPE)	0.12%	Distance From Antenna To Maximum Composite Power Density for all Frequency Bands (feet):	40
Comments: The proposed facility has a predicted maximum power density value of 0.12 % of the FCC's general public allowable limit for emissions exposure at a distance of 40 feet from the antenna location. Therefore this site is Compliant with regards to all FCC regulations for general public exposure to radio frequency emissions.					

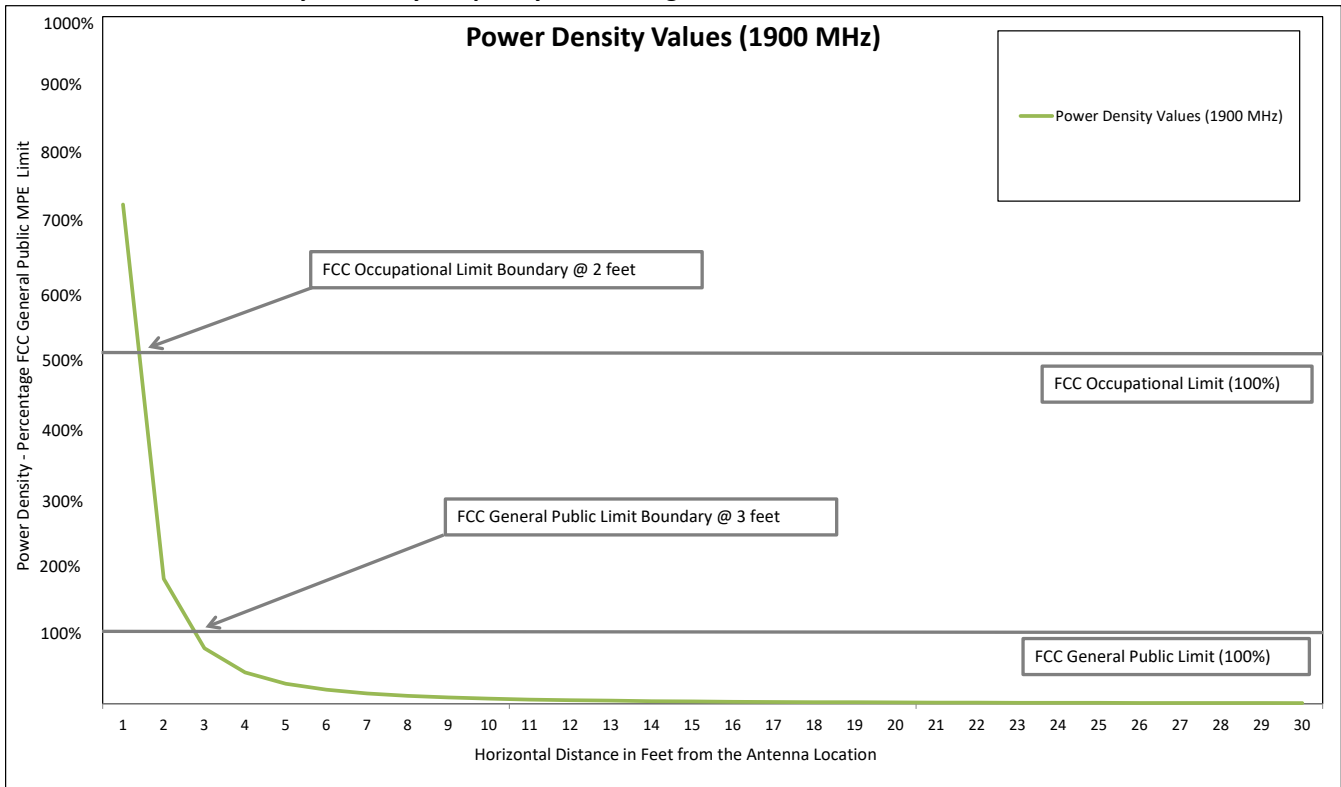
Power Density Values By Frequency Band Along Ground Radial for Location: SC-NY 0227



Centerline Project Number: 950002-015
 Fibertech Project ID: SC-NY 0227

Antenna Location Data For Location:				SC-NY 0227	
Location Number:	SC-NY 0227	Antenna Make:	Antenna Products	Equipment Manufacturer:	Alcatel Lucent
Latitude (N):	40.722834	Antenna Model:	0-6002V-Z4-F4T	Equipment Model:	CMRO
Longitude (W):	-74.01057	Antenna Azimuth (Degrees):	Omni	Number of Antennas at Location:	1
Emissions Compliance:	Compliant	Antenna Height (ft):	30.00	Analysis Location:	Antenna Level
Total TX Power_ 1900 MHz (Watts):	10	Maximum Power Density at 1900 MHz (% MPE)	726.56%	Distance From Antenna To Maximum Power Density Location at 1900 MHz (feet):	1
Cable Loss (dB):	0	Splitter / Combiner Loss (dB):	0	Additional System Gains (dB):	0
Distance from antenna face that exceeds the FCC's Occupational Threshold for Radio Frequency Emissions- Maximum Value at Antenna Level (feet):			2 feet		
Distance from antenna face that exceeds the FCC's General Public Threshold for Radio Frequency Emissions - Maximum Value at Antenna Level (feet):			3 feet		
Total Site EIRP (Watts):	32.36	Maximum Composite Power Density for all Frequency Bands (% MPE)	726.56%	Distance From Antenna To Maximum Composite Power Density for all Frequency Bands (feet):	1
Comments: The proposed facility has a predicted maximum power density value of 726.56% of the FCC's general public allowable limit for emissions exposure (145.31% of the FCC's Occupational allowable limit for emissions exposure) at a distance of 1 feet from the antenna location.					

Power Density Values By Frequency Azim Band Along Antenna Level Radial for Location: SC-NY 0227



Centerline Project Number: 950002-015
 Fibertech Project ID: SC-NY 0227

Signage Recommendations




Sign Image	Description	Posting Instructions
	<p>Blue Notice Sign</p> <p>8-1/2" x 11", used to alert individuals that they are entering an area where the power density emitted from transmit antennas is within the FCC's maximum permissible exposure limit for the general population.</p>	<p>Securely post at the equipment attachment point on the utility pole in a manner conspicuous to all individuals entering thereon.</p> <p>Denote Site ID Number on Sign in Permanent Marker.</p>
	<p>Yellow Caution Sign</p> <p>8-1/2" x 11", used to alert individuals that they are entering an area where the power density emitted from transmit antennas may exceed the FCC's maximum permissible exposure limit for the general population, but is less than the occupational exposure limit.</p>	<p>Securely post on the utility pole 4 feet below the antenna centerline (26 feet AGL) in a manner conspicuous to all individuals entering thereon. This sign will notify trained personnel that they are entering an area that may exceed the FCC's maximum permissible limit for general population exposure</p> <p>Denote Site ID Number on Sign in Permanent Marker.</p>
	<p>Red Warning Sign</p> <p>8-1/2" x 11", used to alert individuals that they are entering an area where the power density emitted from the above antennas may exceed the FCC's maximum permissible limit for occupational exposure.</p>	<p>Securely post on the utility pole 3 feet below the antenna centerline (27 feet AGL) in a manner conspicuous to all individuals entering thereon. This sign will notify trained personnel that they are entering an area that may exceed the FCC's maximum permissible limit for occupational exposure</p> <p>Denote Site ID Number on Sign in Permanent Marker.</p>

Table 4: Emissions Notice, Caution and Warning Signs



Summary

All ground level calculations performed for this analysis yielded results that were well within the FCC's allowable limits for general population exposure to RF Emissions. There were, however, areas in close proximity to the antenna mounting height that potentially exceed the FCC's maximum allowable limit for general population and occupational exposure.

At ground level, there were no areas that exceeded the FCC's maximum allowable limit for general population or occupational exposure to radio frequency emissions resulting from this proposed facility. The anticipated maximum composite MPE value calculated along the ground level radial was **0.12%** of the allowable FCC maximum allowable limit for general population exposure to radio frequency emissions (**0.024%** of the allowable FCC maximum allowable limit for occupational exposure). At the antenna level, there exists an area that extends approximately **2 feet** from the antenna face that may exceed the FCC's maximum allowable limit for occupational exposure and an area that extends approximately **3 feet** from the antenna face that may exceed the FCC's maximum allowable limit for general population exposure to radio frequency emissions. This is based upon site configuration data provided by Lighttower and listed within this report.

FCC guidelines state that if a site is found to be out of compliance (over allowable thresholds), that carriers over a 5% contribution to the composite value will require measures to bring the site into compliance. The listed signage recommendations will bring the facility into compliance by ensuring that anyone entering an area that may exceed either the FCC's allowable FCC maximum allowable limit for general population or occupational exposure will be properly noticed.

A handwritten signature in black ink, appearing to read 'Scott Heffernan', is positioned above the printed name.

Scott Heffernan
RF Engineering Director

Centerline Communications

95 Ryan Drive, Suite 1
Raynham, MA 02767



Appendix A:

Antenna Specification Sheet

O-6002v-Z4-F4

Quad Band PCS/AWS/LTE 4x4 MIMO Small Cell o-DAS Antenna



Product Description

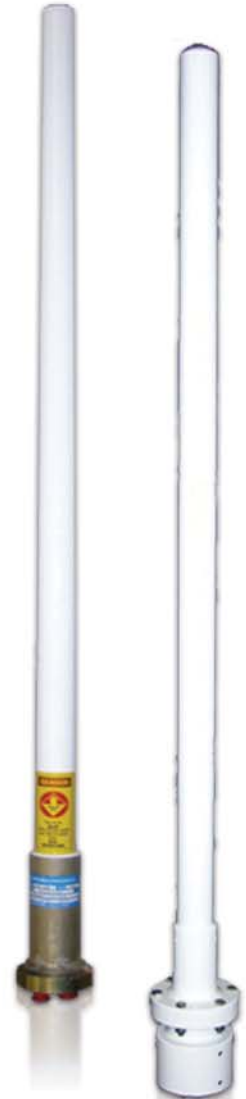
Model Number	O-6002v-Z4-F4T (Top mount) O-6002v-Z4-F4S (Side mount)
Operating Frequency Band	1695-2180 MHz

Electrical Specifications

Frequency Range, MHz	1695-1850 1850-1990 2110-2180
Gain, dBi	4.3 5.1 4.9
Horizontal Beamwidth, degrees	360
Vertical Beamwidth, degrees +/-1	41 36 39
VSWR, dB	1.7:1
PIM, dBc	< -150
Input Power per Port, watts (max)	100
Polarization	Vertical
Isolation, dB	> 15 > 15 >15
Impedance, ohms	50
Azimuth Ripple, +/- dB	0.5

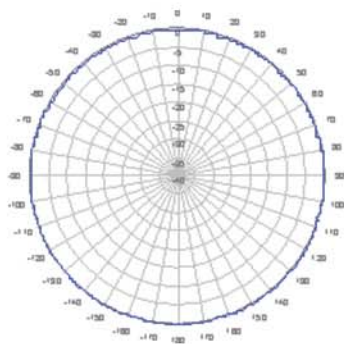
Mechanical & Environmental Specifications

Connector	4 x 4.3-10 DIN
Mounting	Top mount (Mounts over 2.0" OD post) Side mount (Mounts to 1 3/4" - 3" OD post)
Dimensions	60" x 2.0" O.D.
Weight	< 10 lbs.
Color	White - Standard (Color Options Available)
Wind Survival	120 mph.
Lightning Protection	Direct Ground

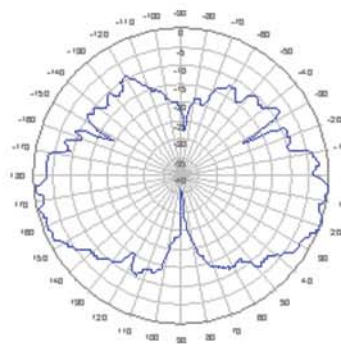


Patterns

Azimuth



Elevation





Appendix B:

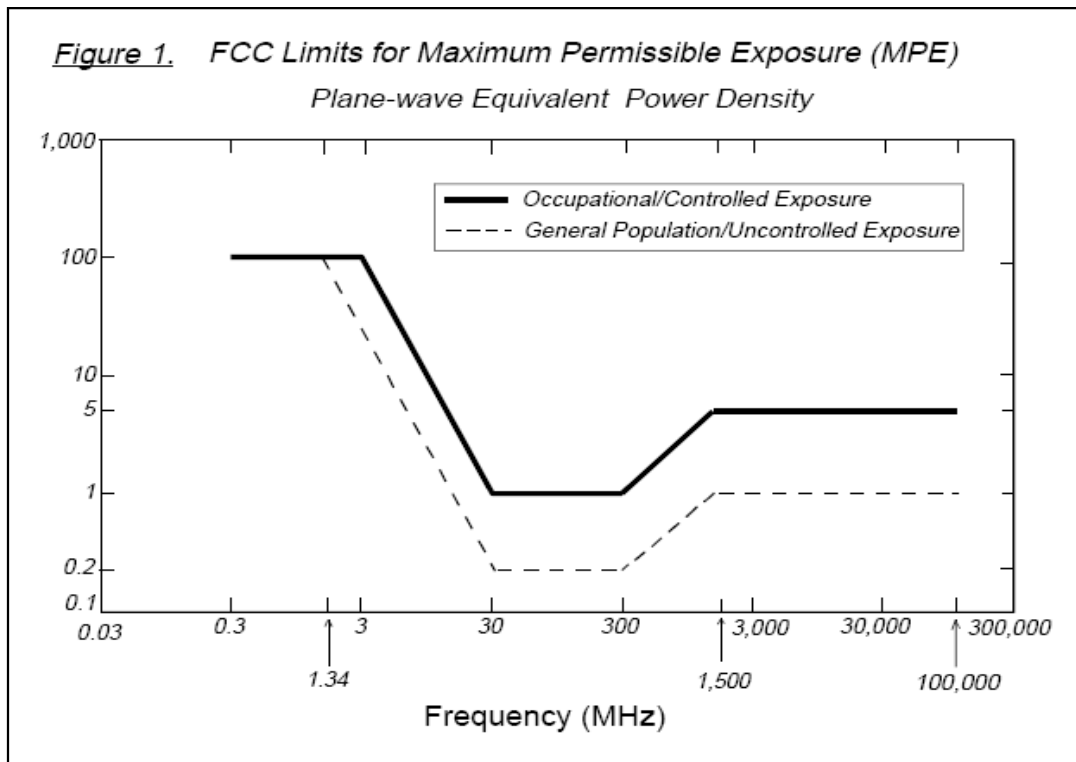
Regulatory Information

APPENDIX A: FCC Emissions Threshold Limits

Table 1: Limits for Maximum Permissible Exposure (MPE)				
(A) Limits for Occupational/Controlled Exposure				
Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm ²)	Averaging Time [E] ² , [H] ² , or S (minutes)
0.3-3.0	614	1.63	(100)*	6
3.0-30	1842/f	4.89/f	(900/f ²)*	6
30-300	61.4	0.163	1.0	6
300-1,500	--	--	f/300	6
1,500-100,000	--	--	5	6
(B) Limits for General Public/Uncontrolled Exposure				
Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm ²)	Averaging Time [E] ² , [H] ² , or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	(180/f ²)*	30
30-300	27.5	0.073	0.2	30
300-1,500	--	--	f/1,500	30
1,500-100,000	--	--	1.0	30

f = Frequency in (MHz)

* Plane-wave equivalent power density





Appendix C:

On Site Measurements



On Site Measurements

On Site Measurements were taken by Centerline Communications at the existing Lighttower antenna location located at the intersection of Vestry and Washington Streets in New York, NY on October 30, 2017. Additionally, measurements were made inside an adjacent second floor apartment. The purpose of this visit was to determine whether all locations surveyed were in compliance with federal limits for radio frequency emissions.

Centerline Communications performed measurements utilizing the NARDA NBM520 RF meter and the NARDA EA5091 Shaped response wide-banded RF probe. The shaped probe allows for sampling of a wide range of frequencies from 300 KHz to 50 GHz. The Power meter allows for composite emissions values (power density) for this entire range to allow for the composite analysis of all signals within this range incident upon each sample point.

The first areas analyzed were ground level locations near by the existing antenna location. Below is a table (Table 5) of results for each location measured on the site survey and their values. Each location was measured utilizing a Max Peak method that displays the maximum value encountered at each location instead of an average as is done many times. This allows for a true worst-case scenario sampling at each of the sample points. Exhibit A shows the outdoor points from Table 5 on an aerial map.

Survey Points			
Loc #	Distance from Antenna (ft)	% Occupational MPE	% Gen Pop MPE
M1	6	1.106	5.530
M2	50	2.076	10.380
M3	75	0.081	0.405
M4	75	2.952	14.760
M5	90	1.653	8.265
M6	30	0.778	3.890
M7	50	1.231	6.155
M8	70	2.455	12.275
M9	30	0.187	0.935
M10	60	0.208	1.040
M11	66	1.843	9.215
M12	30	0.164	0.820
M13	60	0.017	0.085
M14	At Ground Level at Site	0.09 %	0.45 %

Table 5: On Site Survey Points and Values (outdoors)



Exhibit A: External Survey Points

The drawing below details the results of the measurements taken inside the second floor of the nearest adjacent apartment building located to the east of the antenna location.

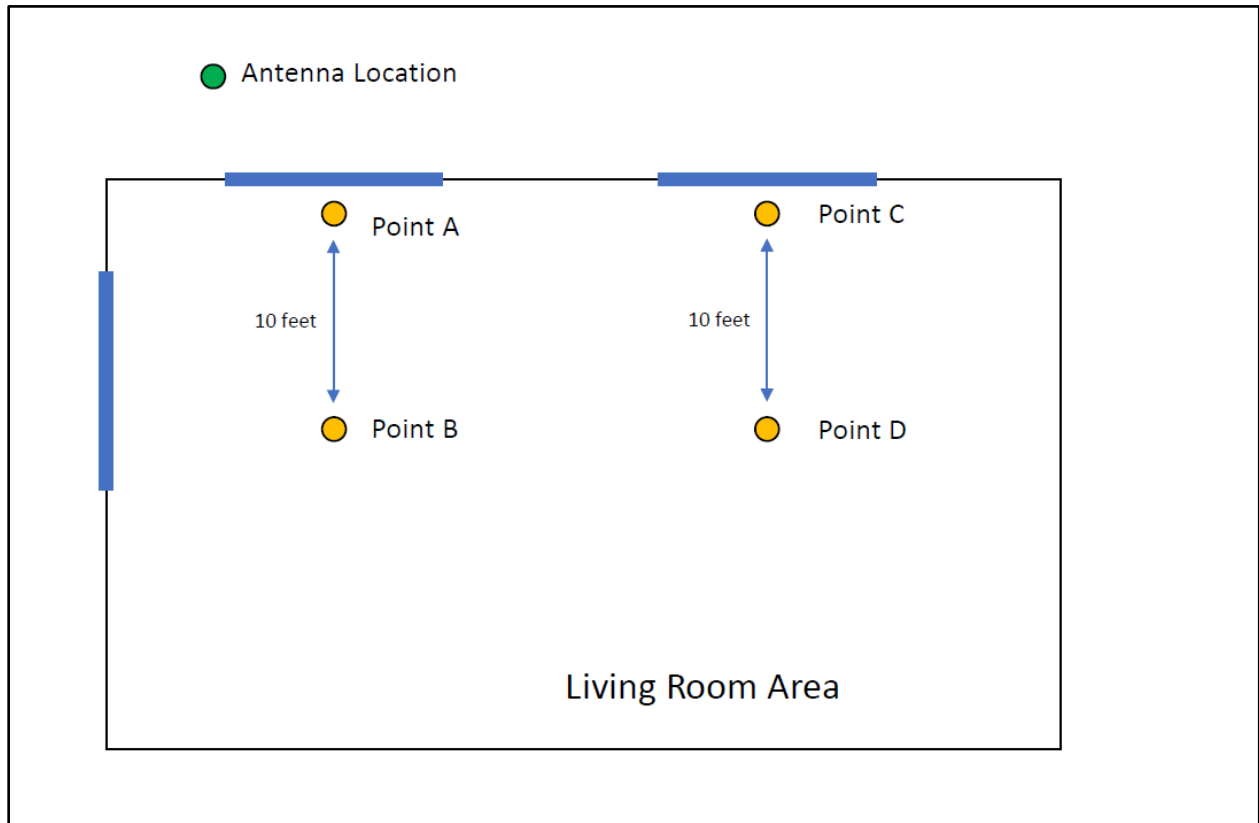


Exhibit B: Living Room Area

Point ID	MPE% (Occupational)	MPE% (General Population)
Point A	0.002	0.010
Point B	0.261	1.305
Point C	0.067	0.335
Point D	0.106	0.530

Table 6: Living Room Values



On Site Measurements Summary

All points surveyed, both indoors and outdoors, yielded values that were well within the FCC limits for general population exposure to radio frequency emissions. The areas surveyed are all considered compliant for these standards.

One point to mention is the windows installed in the second-floor apartment are Double E High Film rated windows that make it difficult for radio frequency emissions to pass through.

There was a macro cell site for an unknown carrier on a near by rooftop. The emissions from this and all surrounding facilities were collected as part of the composite values at each survey point.