Radio Frequency Emissions Analysis Report

Sprint Wireless Water Tank Facility

Site ID: BS23XC490
Site Name: Cedar St. Water Tank
Address: 396 Cedar Street,
Ashland, MA 01721
Latitude: 42.235300
Longitude: -71.439800

Prepared for:
Sprint
1 International Boulevard, Suite 800
Mahwah, NJ 07495

Centerline PN: 950026-002

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GENERAL SUMMARY

Centerline Communications, LLC ("Centerline") has been contracted to provide a Radio Frequency (RF) Analysis for the following Sprint wireless water tank facility to determine whether the facility is in compliance with federal standards and regulations regarding RF emissions. This analysis includes theoretical emissions calculations, for all proposed equipment for Sprint.

SITE SUMMARY

Analysis Site Data	
Site ID:	BS23XC490
Site Name:	Cedar St. Water Tank
Site Address:	396 Cedar Street, Ashland MA 01721
Site Latitude:	42.235300 N
Site Longitude:	-71.439800 W
Facility Type:	Water Tank
Compliance Summary	
Compliance Status:	Compliant Upon Mitigation Installation
Maximum Modeled MPE% on Walking Surface Sprint (General Public Limit):	3.30 %
Maximum Modeled MPE% at Ground Level Sprint (General Public Limit):	3.30 %
Is Access Locked or Controlled? :	Controlled
Lock or Control Measures if Present:	N/A

It was noted that other carrier antennas were on site. However, there was not enough information available to include them in the modeling analysis.

FCC GUIDELINES

All power density values used in this report were analyzed as a percentage of current Maximum Permissible Exposure (% MPE) as listed in the FCC OET Bulletin 65 Edition 97-01and ANSI/IEEE Std C95.1. The FCC regulates Maximum Permissible Exposure in units of microwatts per square centimeter ($\mu W/cm^2$). The number of $\mu W/cm^2$ 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 public 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 public 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.

Public exposure to radio frequencies is regulated and enforced in units of microwatts per square centimeter ($\mu W/cm^2$). The general population exposure limit for the 700 and 800 MHz Bands is approximately 467 $\mu W/cm^2$ and 567 $\mu W/cm^2$ respectively, and the general population exposure limit for the 1900 MHz PCS and 2100 MHz AWS bands is 1000 $\mu W/cm^2$. Because each carrier will be using different frequency bands, and each frequency band has different exposure limits, it is necessary to report percent of MPE rather than power density.

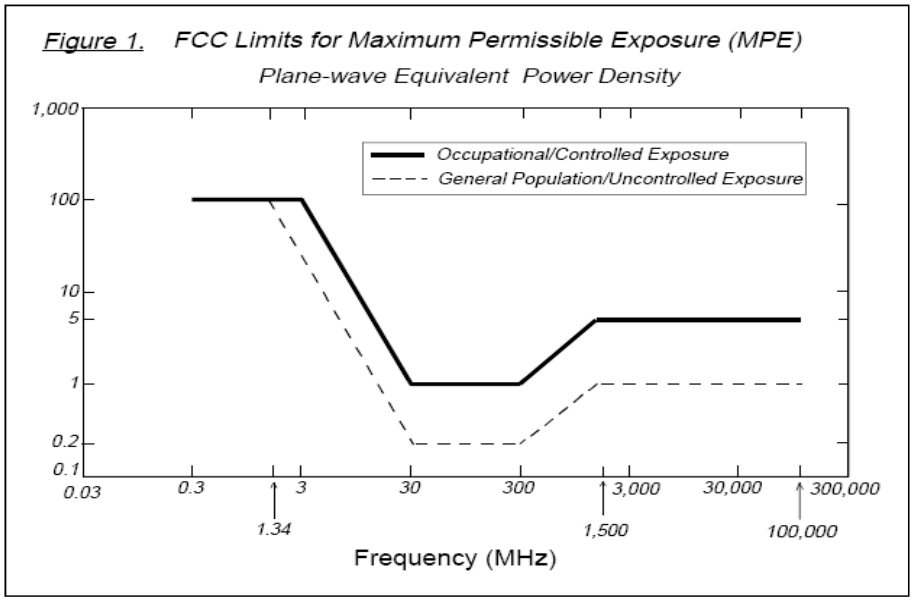
Occupational/Controlled exposure limits apply to situations in which persons are exposed as a consequence of their employment and in which those persons who are exposed have been made fully aware of the potential for exposure, have been properly trained in RF safety and can exercise control over their 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, have been trained in RF safety and can exercise control over his or her exposure by leaving the area or by some other appropriate means. The Occupational/Controlled exposure limits all utilized frequency bands is five (5) times the FCC's General Public / Uncontrolled exposure limit.

Additional details can be found in FCC OET 65.

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-I,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-I,500	--	--	f/1,500	30
1,500-100,000	--	--	1.0	30

f = Frequency in (MHz)

* Plane-wave equivalent power density



CALCULATION METHODOLOGY & DATA

Centerline has performed theoretical calculations on all transmission equipment located on this facility. All calculations have been performed using the RoofView® software from Richard Tell Associates. This software performs calculations using a cylindrical model for very conservative power density predictions within the near-field of the antenna where the antenna pattern has not truly formed yet. Within this area power density values tend to decrease based upon an inverse distance function. At the point where it is appropriate for modeling to change from near-field calculations to far-field calculations the power decreases inversely with the square of the distance. This modeling technique is very accurate with very low antenna centerlines, such as rooftops, where persons can get very close to the antennas and pass through fields in close proximity.

The below calculation in Figure 1 shows the theoretical distribution of power over an imaginary cylinder with equal power distribution in all directions.

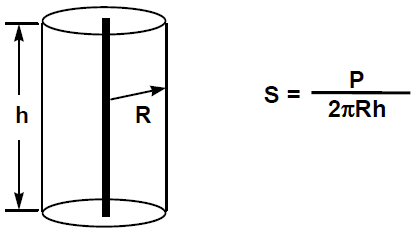


Figure 1: Distribution of power over an imaginary cylinder in all directions

This model can be modified for directional antennas to show directionality of power distribution. This formula will tend to be conservative as it assumes that all power is focused between the 3 dB power roll off points as shown in Figure 2.

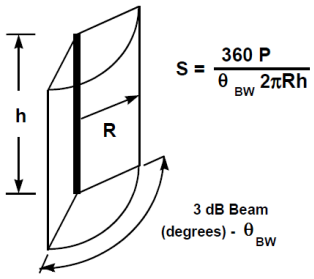


Figure 2: Distribution of power over an imaginary cylinder between the half power (3dB) power roll off points (HBW) for directional antennas

ANTENNA INVENTORY

Sector	Operator	Frequency Band	TX Power Per Channel	# of Channels	ERP	Antenna Make	Antenna Model	Gain (dBd)	Azimuth (°)	Antenna Centerline Height (ft)	Z Value (ft)**
A	Sprint	CDMA 850 LTE 850 CDMA 1900 LTE 1900	20 20 16 40	1 2 5 2	7541	RFS	APXVSPP18-C-A20	15.9 15.9 15.9 15.9	10	80.2	77.2
A	Sprint	LTE 2500	20	8	8019	Commscope	DT465B-2XR	17.5	10	80.2	77.2
B	Sprint	CDMA 850 LTE 850 CDMA 1900 LTE 1900	20 20 16 40	1 2 5 2	7541	RFS	APXVSPP18-C-A20	15.9 15.9 15.9 15.9	170	80.2	77.2
B	Sprint	LTE 2500	20	8	8019	Commscope	DT465B-2XR	17.5	170	80.2	77.2
C	Sprint	CDMA 850 LTE 850 CDMA 1900 LTE 1900	20 20 16 40	1 2 5 2	7541	RFS	APXVSPP18-C-A20	15.9 15.9 15.9 15.9	270	80.2	77.2
C	Sprint	LTE 2500	20	8	8019	Commscope	DT465B-2XR	17.5	270	80.2	77.2

*Table 1: Total Site data table **(Z Value is distance from bottom of antenna to walking surface)*

RESULTS

All calculations performed based upon the data listed for this facility have produced results that are within allowable limits for General Population and Occupational limits for exposure to RF emissions as specified by federal standards. Sprint can ensure compliance on this facility by following the signage and barrier recommendations presented in this report.

The anticipated maximum power density value (% MPE) calculated in front of any of the Sprint sectors is **3.30 %** of the FCC's allowable limit for General Population exposure to radio frequency emissions (**0.66 %** of the FCC's allowable Occupational limit). This was determined based upon worst-case theoretical modeling as described in this report for all walking surfaces in close proximity to the antenna arrays. The following is a summary for each Sprint Sector.

Sector A: There are no areas that exceed the **FCC's General Population or Occupational limits** for exposure to radio frequency emissions. The maximum power density value (% MPE) calculated for Sprint's Sector A antennas is **3.30 %** of the FCC's allowable limit for General Population exposure to radio frequency emissions (**0.66 %** of the FCC's allowable Occupational limit). The Sector A antennas are transmitting over the ground level.

Sector B: There are no areas that exceed the **FCC's General Population or Occupational limits** for exposure to radio frequency emissions. The maximum power density value (% MPE) calculated for Sprint's Sector B antennas is **3.30 %** of the FCC's allowable limit for General Population exposure to radio frequency emissions (**0.66 %** of the FCC's allowable Occupational limit). The Sector B antennas are transmitting over the ground level.

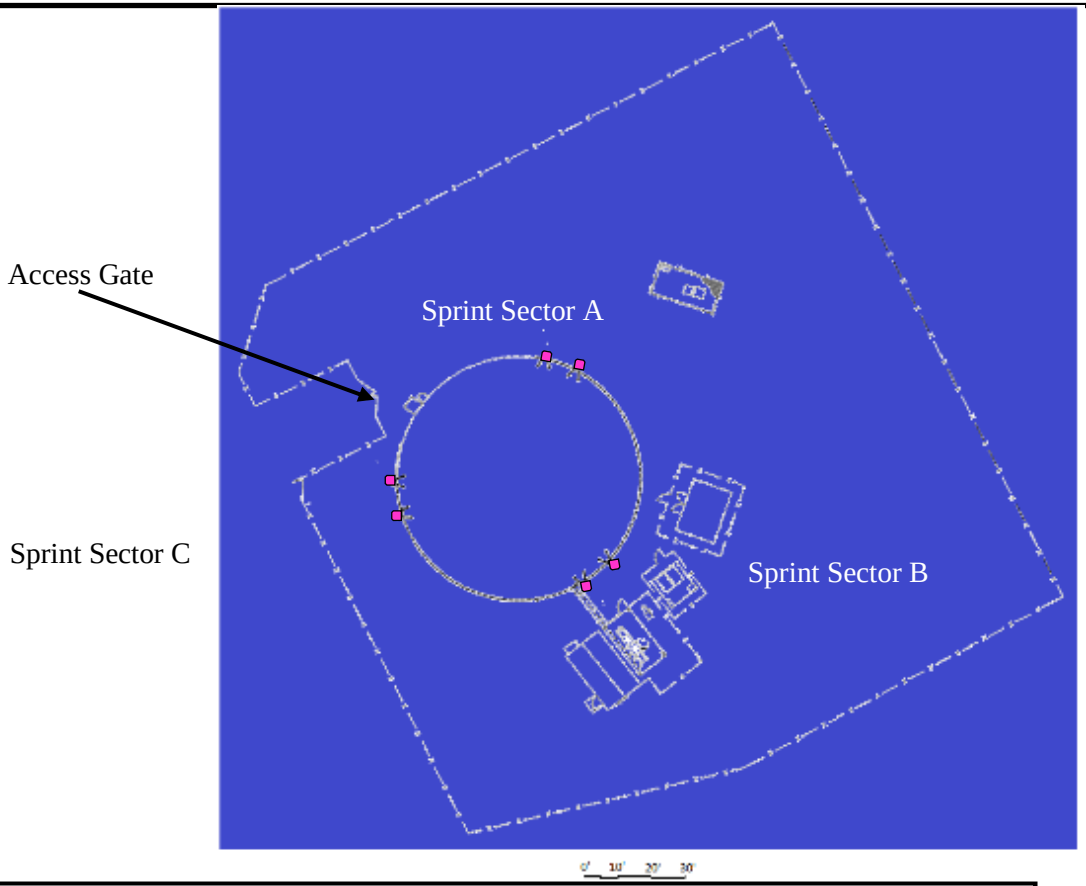
Sector C: There are no areas that exceed the **FCC's General Population or Occupational limits** for exposure to radio frequency emissions. The maximum power density value (% MPE) calculated for Sprint's Sector C antennas is **3.30 %** of the FCC's allowable limit for General Population exposure to radio frequency emissions (**0.66%** of the FCC's allowable Occupational limit). The Sector C antennas are transmitting over the ground level.

At the ground level the maximum power density value calculated from the Sprint radio equipment is **3.30 %** of the **FCC's General Population limit** for exposure to radio frequency emissions. At ground level the maximum composite power density for all system operators on this facility is **0.66 %** of the **FCC's Occupational limit** for exposure to radio frequency emissions.

The FCC mandates that if a site is found to be out of compliance with regard to emissions that any system operator contributing 5% or more to areas exceeding the FCC's allowable limits, as outlined in this report, will be responsible for bringing the site into compliance.

Signage and barriers are the primary means of mitigating access to accessible areas of exposure. It is recommended that blue Notice signs are installed at all access points to the rooftop. Barriers and signage at the sectors are recommended to control access to any areas of exposure near the antennas.

A Composite emissions threshold plot which graphically shows power density values is shown following in **Exhibit 1a – Emissions Thresholds for Walking Surfaces.**



Operator Antenna Identifiers

Sprint Antennas

Emissions Value Over 500% GP limit

100 % GP Limit < Emissions Value ≤ 500% GP Limit

Emissions Value < 100% GP Limit

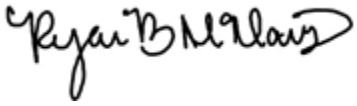
Exhibit 1a:

Emissions Thresholds for Walking Surfaces

Cedar St. Water Tank / BS25XC364

APPENDIX A: CERTIFICATIONS

I, Ryan McManus, preparer of this report certify that I am fully trained and aware of the Rules and Regulations of both the Federal Communications Commissions (FCC) and the Occupational Safety and Health Administration (OSHA) with regard to Human Exposure to Radio Frequency Radiation. I have been trained in the procedures and requirements outlined by Sprint.



_____ 6/20/2018

I, Scott Heffernan, reviewer and approver of this report certify that I am fully trained and aware of the Rules and Regulations of both the Federal Communications Commissions (FCC) and the Occupational Safety and Health Administration (OSHA) with regard to Human Exposure to Radio Frequency Radiation. I have been trained in the procedures and requirements outlined by Sprint.

_____ 6/20/2018