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March 28, 2023

Melanie A. Bachman, Esq.
Executive Director/Staff Attorney
Connecticut Siting Council
10 Franklin Square
New Britain, CT 06051

Re: **EM-VER-104-221024 – Cellco Partnership d/b/a Verizon Wireless – 2 Hinckley Hill Road, Norwich, Connecticut**

Dear Attorney Bachman:

On March 2, 2023 I sent you a Calculated Radio Frequency (RF) Report, prepared by C-Squared Systems presenting a cumulative far-field analysis for all carriers on the tower, submitted pursuant to Condition No. 2 of the Council's approval of EM-VER-104-221024. Martin Lavin at C-Squared recently discovered an error in the initial RF Report and provided the attached updated RF Report for your records.

Please contact me if you have any questions regarding this proposal.

Sincerely,

Kenneth C. Baldwin

Attachments

C Squared Systems, LLC
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Calculated Radio Frequency Emissions Report

NORWICH EAST

2 Hinckley Hill Road, Preston, CT 06365

March 28, 2023

Table of Contents

List of Figures

List of Tables

1. Introduction

The purpose of this report is to investigate compliance with applicable FCC regulations for the proposed modification of Verizon's antenna arrays to be mounted at 127.5' AGL on an existing self-support lattice tower located at 2 Hinckley Hill Road in Preston, CT. The coordinates of the monopole tower are 41° 30' 53.4528" N, 72° 3' 42.0768" W.

Verizon is proposing the following:

1) Install three (3) multi-band antennas (one (1) per sector) to support its commercial LTE network.

This report considers the planned antenna configuration for Verizon[1] to derive the resulting % MPE of its proposed installation.

2. FCC Guidelines for Evaluating RF Radiation Exposure Limits

In 1985, the FCC established rules to regulate radio frequency (RF) exposure from FCC licensed antenna facilities. In 1996, the FCC updated these rules, which were further amended in August 1997 by OET Bulletin 65 Edition 97-01. These new rules include Maximum Permissible Exposure (MPE) limits for transmitters operating between 300 kHz and 100 GHz. The FCC MPE limits are based upon those recommended by the National Council on Radiation Protection and Measurements (NCRP), developed by the Institute of Electrical and Electronics Engineers, Inc., (IEEE) and adopted by the American National Standards Institute (ANSI).

The FCC general population/uncontrolled limits set the maximum exposure to which most people may be subjected. General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or cannot exercise control over their exposure.

Public exposure to radio frequencies is regulated and enforced in units of milliwatts per square centimeter (mW/cm^2). The general population exposure limits for the various frequency ranges are defined in the attached "FCC Limits for Maximum Permissible Exposure (MPE)" in Attachment C of this report.

Higher exposure limits are permitted under the occupational/controlled exposure category, but only for persons who are exposed as a consequence of their employment and who have been made fully aware of the potential for exposure, and they must be able to exercise control over their exposure. General population/uncontrolled limits are five times more stringent than the levels that are acceptable for occupational, or radio frequency trained individuals. Attachment C contains excerpts from OET Bulletin 65 and defines the Maximum Exposure Limit.

Finally, it should be noted that the MPE limits adopted by the FCC for both general population/uncontrolled exposure and for occupational/controlled exposure incorporate a substantial margin of safety and have been established to be well below levels generally accepted as having the potential to cause adverse health effects.

[1] As referenced to Verizon's Radio Frequency Design Sheet updated 11/09/2021.

3. RF Exposure Prediction Methods

The emission field calculation results displayed in the following figures were generated using the following formula as outlined in FCC bulletin OET 65:

$$\text{PowerDensity} = \left(\frac{EIRP}{\pi \times R^2} \right) \times \text{Off BeamLoss}$$

Where:

EIRP = Effective Isotropic Radiated Power

R = Radial Distance = $\sqrt{\left(H^2 + V^2\right)}$

H = Horizontal Distance from antenna in meters

V = Vertical Distance from radiation center of antenna in meters

Off Beam Loss is determined by the selected antenna patterns

Ground reflection factor of 1.6

These calculations assume that the antennas are operating at 100 percent capacity, that all antenna channels are transmitting simultaneously, and that the radio transmitters are operating at full power. Obstructions (trees, buildings, etc.) that would normally attenuate the signal are not taken into account. The calculations assume even terrain in the area of study and do not take into account actual terrain elevations which could attenuate the signal. As a result, the predicted signal levels reported below are much higher than the actual signal levels will be from the final installations.

4. Antenna Inventory

Table 1 below outlines Verizon's proposed antenna configuration for the site. The associated data sheets and antenna patterns for these specific antenna models are included in Attachments C.

Operator	Sector / Call Sign	TX Freq (MHz)	Power at Antenna (Watts)	Ant Gain (dBi)	Power EIRP (Watts)	Antenna Model	Beam Width	Mech. Tilt	Length (ft)	Antenna Centerline Height (ft)
Verizon	Alpha / 30°	700	160	14.5	4509	JAHH-65B-R3B	67	0	5.99	127.5
		850	160	15.8	6083		65			
		1900	160	18.4	11069		65			
		2100	240	18.5	16990		68			
		3700	200	25.5	70962	MT6407-77A	-	0	2.92	127.5
	Beta / 135°	700	160	14.5	4509	JAHH-65B-R3B	67	0	5.99	127.5
		850	160	15.8	6083		65			
		1900	160	18.4	11069		65			
		2100	240	18.5	16990		68			
		3700	200	25.5	70962	MT6407-77A	-	0	2.92	127.5
	Gamma / 260°	700	160	14.5	4509	JAHH-65B-R3B	67	0	5.99	127.5
		850	160	15.8	6083		65			
		1900	160	18.4	11069		65			
		2100	240	18.5	16990		68			
		3700	200	25.5	70962	MT6407-77A	-	0	2.92	127.5

Table 1: Proposed Antenna Inventory[2][3]

[2] Antenna heights are in reference to Verizon's Radio Frequency Design Sheet updated 11/09/2021.

[3] Transmit power assumes 0 dB of cable loss.

5. Calculation Results

The calculated power density results are shown in Figure 1 below. For completeness, the calculations for this analysis range from 0 feet horizontal distance (directly below the antennas) to a value of 3,000 feet horizontal distance from the site. In addition to the other worst-case scenario considerations that were previously mentioned, the power density calculations to each horizontal distance point away from the antennas was completed using a local maximum off beam antenna gain (within ± 5 degrees of the true mathematical angle) to incorporate a realistic worst-case scenario.

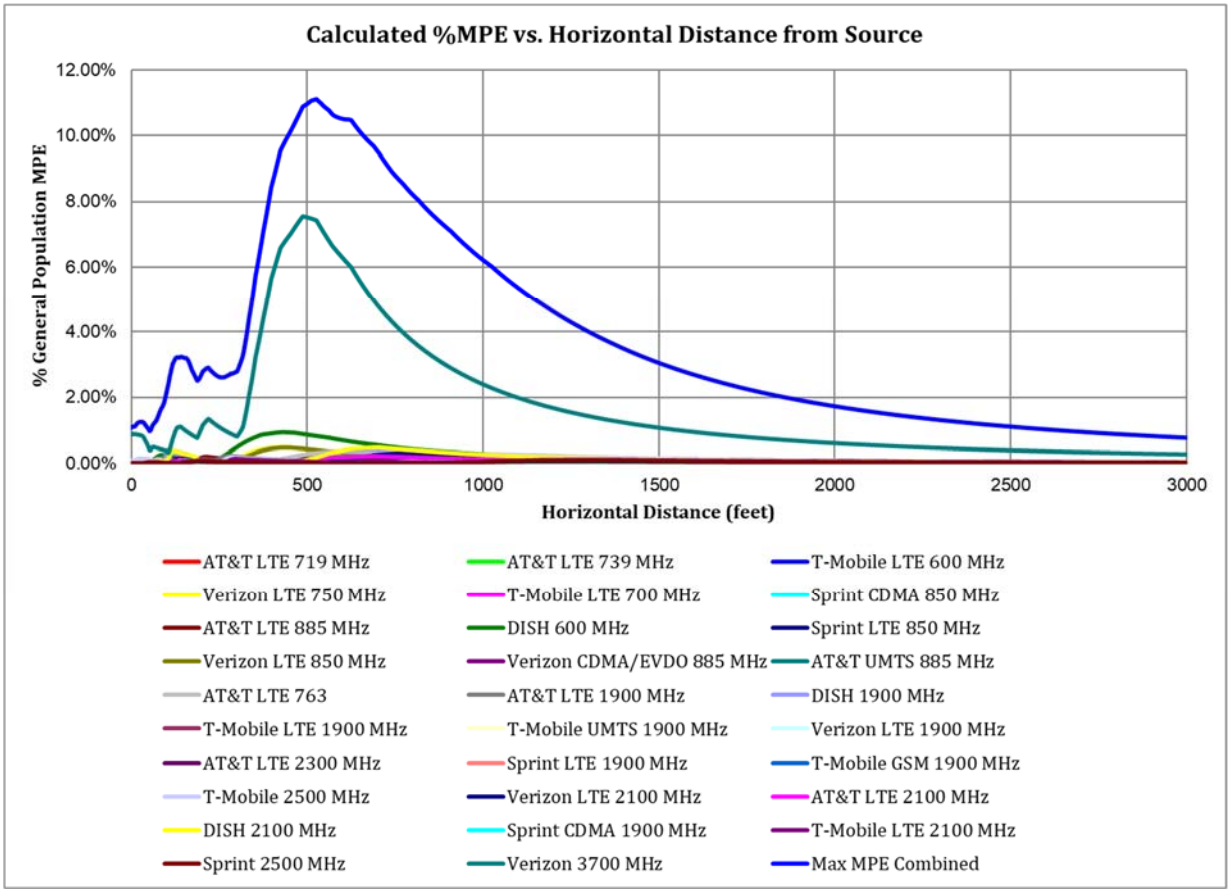


Figure 1: Graph of General Population % MPE vs. Distance

The highest percent of MPE (11.11**%** of the General Population limit) is calculated to occur at a horizontal distance of 526 feet from antennas. Please note that the percent of MPE calculations close to the site take into account off beam loss, which is determined from the vertical pattern of the antennas used. Therefore, RF power density levels may increase as the distance from the site increases. At distances of approximately 1500 feet and beyond, one would now be in the main beam of the antenna pattern and off beam loss is no longer considered. Beyond this point, RF levels become calculated solely on distance from the site and the percent of MPE decreases significantly as distance from the site increases.

Table 2 below lists percent of MPE values as well as the associated parameters that were included in the calculations. The highest percent of MPE value was calculated to occur at a horizontal distance of 526 feet from the site (reference Figure 1).

As stated in Section 3, all calculations assume that the antennas are operating at 100 percent capacity, that all antenna channels are transmitting simultaneously, and that the radio transmitters are operating at full power. Obstructions (trees, buildings etc.) that would normally attenuate the signal are not taken into account. In addition, a six foot height offset was considered in this analysis to account for average human height. As a result, the predicted signal levels are significantly higher than the actual signal levels will be from the final configuration. The results presented in Figure 1 and Table 2 assume level ground elevation from the base of the tower out to the horizontal distances calculated.

Carrier	Number of Transmitters	Power out of Base Station Per Transmitter (Watts)	Antenna Height (Feet)	Distance to the Base of Antennas (Feet)	Power Density (mW/cm^2)	Limit (mW/cm^2)	% MPE
AT&T LTE 1900 MHz	1	160.0	115.0	526	0.000736	1.000	0.07%
AT&T LTE 2100 MHz	1	160.0	115.0	526	0.001023	1.000	0.10%
AT&T LTE 2300 MHz	1	100.0	115.0	526	0.000603	1.000	0.06%
AT&T LTE 719 MHz	1	80.0	115.0	526	0.000918	0.479	0.19%
AT&T LTE 739 MHz	1	160.0	115.0	526	0.001239	0.493	0.25%
AT&T LTE 763	1	160.0	115.0	526	0.001565	0.509	0.31%
AT&T LTE 885 MHz	1	160.0	115.0	526	0.001514	0.590	0.26%
AT&T UMTS 885 MHz	1	160.0	115.0	526	0.000195	0.590	0.03%
DISH 1900 MHz	1	160.0	105.0	526	0.001880	1.000	0.19%
DISH 2100 MHz	1	160.0	105.0	526	0.001756	1.000	0.18%
DISH 600 MHz	1	246.0	105.0	526	0.003300	0.400	0.82%
Sprint 2500 MHz	1	160.0	140.0	526	0.000122	1.000	0.01%
Sprint CDMA 1900 MHz	1	80.0	140.0	526	0.000055	1.000	0.01%
Sprint CDMA 850 MHz	1	20.0	140.0	526	0.000038	0.567	0.01%
Sprint LTE 1900 MHz	1	80.0	140.0	526	0.000055	1.000	0.01%
Sprint LTE 850 MHz	1	40.0	140.0	526	0.000075	0.567	0.01%
T-Mobile 2500 MHz	1	240.0	150.0	526	0.000450	1.000	0.05%
T-Mobile GSM 1900 MHz	1	120.0	150.0	526	0.000481	1.000	0.05%
T-Mobile LTE 1900 MHz	1	160.0	150.0	526	0.000641	1.000	0.06%
T-Mobile LTE 2100 MHz	1	120.0	150.0	526	0.000420	1.000	0.04%
T-Mobile LTE 600 MHz	1	160.0	150.0	526	0.000116	0.400	0.03%
T-Mobile LTE 700 MHz	1	160.0	150.0	526	0.000116	0.500	0.02%
T-Mobile UMTS 1900 MHz	1	80.0	150.0	526	0.000321	1.000	0.03%
Verizon 3700 MHz	1	200.0	127.5	526	0.074291	1.000	7.43%
Verizon CDMA/EVDO 885 MHz	1	20.0	127.5	526	0.000125	0.590	0.02%
Verizon LTE 1900 MHz	1	160.0	127.5	526	0.000278	1.000	0.03%
Verizon LTE 2100 MHz	1	240.0	127.5	526	0.000480	1.000	0.05%
Verizon LTE 750 MHz	1	160.0	127.5	526	0.001957	0.497	0.39%
Verizon LTE 850 MHz	1	160.0	127.5	526	0.002241	0.567	0.40%
						Total	**11.11%**

Table 2: Maximum Percent of General Population Exposure Values[4567]

[4] Antenna information for Dish was taken from Fox Hill Telecom, Inc, Radio Frequency Emissions Analysis Report, dated 07/12/2022

[5] Antenna information for AT&T was taken from Connecticut Siting Council – Notice of Exempt Modification, dated 2/2/2021

[6] Antenna information for T-Mobile was taken from Connecticut Siting Council – Notice of Exempt Modification, dated 9/13/2021

[7] Antenna information for Sprint was taken from Connecticut Siting Council – Notice of Exempt Modification, dated 4/18/2018

6. Conclusion

The above analysis verifies that RF exposure levels from the site with Verizon's proposed antenna configuration will be well below the maximum permissible levels as outlined by the FCC in the OET Bulletin 65 Ed. 97-01. Using the conservative calculation methods and parameters detailed above, the maximum cumulative percent of MPE in consideration of all transmitters is calculated to be **11.11% of the FCC limit (General Population/Uncontrolled)**. This maximum cumulative percent of MPE value is calculated to occur 526 feet away from the site.

7. Statement of Certification

I certify to the best of my knowledge that the statements in this report are true and accurate. The calculations follow guidelines set forth in ANSI/IEEE Std. C95.3, ANSI/IEEE Std. C95.1 and FCC OET Bulletin 65 Edition 97-01.

Report Prepared By: Ram Acharya
RF Engineer 1
C Squared Systems, LLC

March 28, 2023
Date

Reviewed/Approved By: Martin J. Lavin
Senior RF Engineer
C Squared Systems, LLC

March 28, 2023
Date

Attachment A: References

OET Bulletin 65 - Edition 97-01 - August 1997 Federal Communications Commission Office of Engineering & Technology

IEEE C95.1-2005, IEEE Standard Safety Levels With Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz IEEE-SA Standards Board

IEEE C95.3-2002 (R2008), IEEE Recommended Practice for Measurements and Computations of Radio Frequency Electromagnetic Fields With Respect to Human Exposure to Such Fields, 100 kHz-300 GHz IEEE-SA Standards Board

Attachment B: FCC Limits for Maximum Permissible Exposure (MPE)

(A) Limits for Occupational/Controlled Exposure[8]

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (E) (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
300-1500	-	-	f/300	6
1500-100,000	-	-	5	6

(B) Limits for General Population/Uncontrolled Exposure[9]

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (E) (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
300-1500	-	-	f/1500	30
1500-100,000	-	-	1.0	30

f = frequency in MHz * Plane-wave equivalent power density

Table 3: FCC Limits for Maximum Permissible Exposure

[8] Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

[9] General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or cannot exercise control over their exposure.

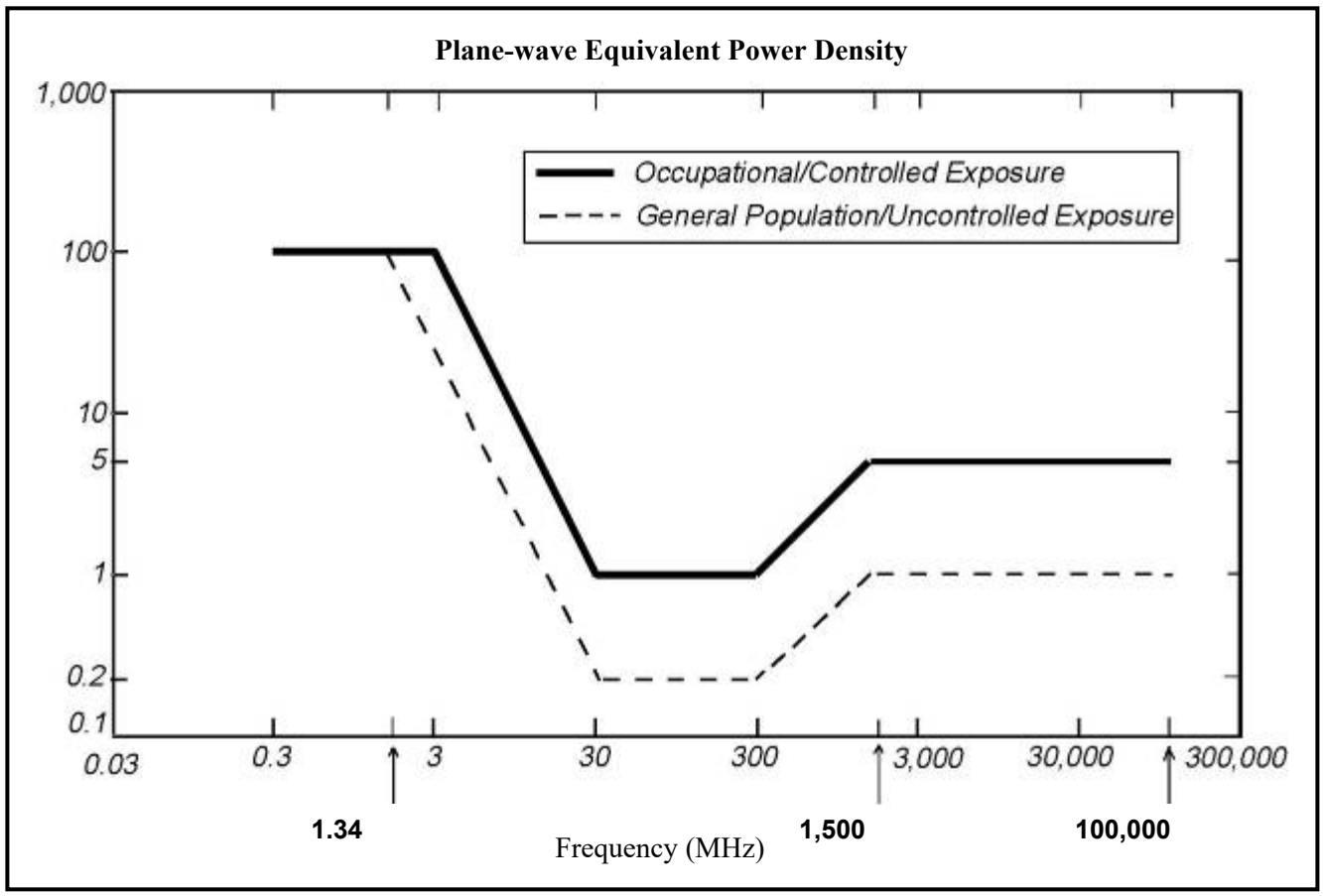
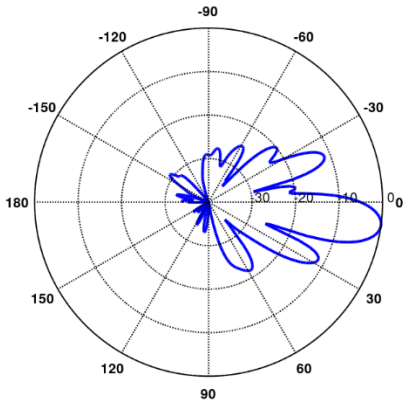


Figure 2: Graph of FCC Limits for Maximum Permissible Exposure (MPE)

Attachment C: Verizon Antenna Model Data Sheets and Electrical Patterns

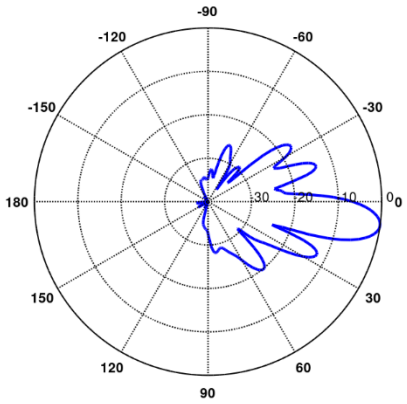
750 MHz

Manufacturer:	COMMSCOPE
Model #:	JAHH-65B-R3B
Frequency Band:	698-787 MHz
Gain:	14.5 dBi
Vertical Beamwidth:	12.4°
Horizontal Beamwidth:	67°
Polarization:	±45°
Dimensions (L x W x D):	71.9” x 13.8” x 8.2”



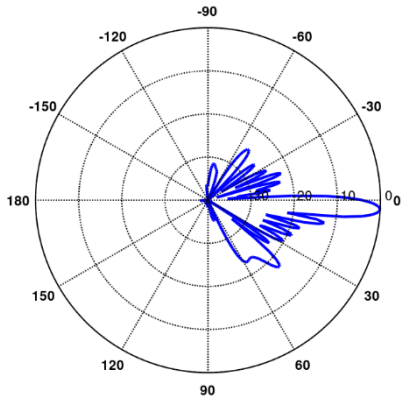
885 MHz

Manufacturer:	COMMSCOPE
Model #:	JAHH-65B-R3B
Frequency Band:	824-894 MHz
Gain:	15.8 dBi
Vertical Beamwidth:	10.5°
Horizontal Beamwidth:	65°
Polarization:	±45°
Dimensions (L x W x D):	71.9” x 13.8” x 8.2”



1900 MHz

Manufacturer:	COMMSCOPE
Model #:	JAHH-65B-R3B
Frequency Band:	1850-1990 MHz
Gain:	18.4 dBi
Vertical Beamwidth:	5.2°
Horizontal Beamwidth:	63°
Polarization:	±45°
Dimensions (L x W x D):	71.9” x 13.8” x 8.2”



2100 MHz

Manufacturer:	COMMSCOPE
Model #:	JAHH-65B-R3B
Frequency Band:	1920-2200 MHz
Gain:	18.5 dBi
Vertical Beamwidth:	4.9°
Horizontal Beamwidth:	65°
Polarization:	±45°
Dimensions (L x W x D):	71.9” x 13.8” x 8.2”