DONALD L. HAES, JR., CHP, CLSO

Radiation Safety Specialist

PO Box 198, Hampstead, NH 03841 617-680-6262 Email: donald_haes_chp@comcast.net

September 16, 2020

RE: Installation of antennas and associated equipment for the AT&T Mobility PWS facility to be mounted on the proposed monopole at 750 Jacobs Road, Montpelier, VT.

PURPOSE

I have reviewed the information pertinent to the proposed installation at the above location. To determine regulatory compliance, theoretical calculations of maximal radio-frequency (RF) fields have been prepared. The physical conditions are that AT&T Mobility proposes to install two (2) personal wireless services (PWS) antennas with remote radio head units each in three (3) sectors, on the proposed monopole at 750 Jacobs Road, Montpelier, VT (See Figure 2).

The theoretical calculations consider the contributions of the proposed AT&T Mobility PWS transmitters operating at their proposed FCC licensed capacity. The calculated RF field values are presented as a percent of current Maximum Permissible Exposures (%MPE) as adopted by the Federal Communications Commission (FCC).[i,ii]

SUMMARY

This report is intended to provide written evidence that RF fields from the proposed AT&T Mobility PWS facility on the ground would comply with the FCC RF exposure guidelines. The resulting data indicate the summation of the proposed AT&T Mobility PWS RF contributions would be within the established RF exposure guidelines in all accessible areas on the ground (see Figure 3). **The results support compliance with the pertinent sections of the FCC's guidelines for RF exposure.**

Based on the results of the theoretical RF fields I have calculated, it is my expert opinion that this facility would comply with all regulatory guidelines for RF exposure with the proposed AT&T Mobility antenna and transmitter installation.

Note: The analyses, conclusions and professional opinions are based upon the precise parameters and conditions of this particular site; **AT&T MOBILITY PWS facility mounted on the proposed monopole at 750 Jacobs Road, Montpelier, VT**. Utilization of these analyses, conclusions and professional opinions for any personal wireless services installation, existing or proposed, other than the aforementioned has not been sanctioned by the author, and therefore should not be accepted as evidence of regulatory compliance.

EXPOSURE LIMITS AND GUIDELINES

RF exposure guidelines enforced by the FCC were established by the American National Standards Institute (ANSI)[iii] and the National Council on Radiation Protection and Measurement (NCRP).[iv] The RF exposure guidelines are listed for RF workers and members of the public. The applicable FCC RF exposure guidelines for the public are listed in Table 1 and depicted in Figure 1. All listed values are intended to be averaged over any contiguous 30-minute period. Note that RF exposure guidelines for trained "RF workers" are five (5) times the values for the general public.

Table 1: Maximum Permissible Exposure (MPE) Values in Public Areas

Frequency Bands	Electric Fields	Magnetic Fields	Equivalent Power Density
0.3–1.34 MHz	614 (V/m)	1.63 (A/m)	(100) mW/cm^2
1.34-30 MHz	824/f (V/m)	2.19/f (A/m)	(100) mW/cm^2
30-300 MHz	27.5 (V/m)	0.073 (A/m)	0.2 mW/cm^2
300-1500 MHz	--	--	f / 1500 mW/cm^2
1500-100,000 MHz	--	--	1.0 mW/cm^2

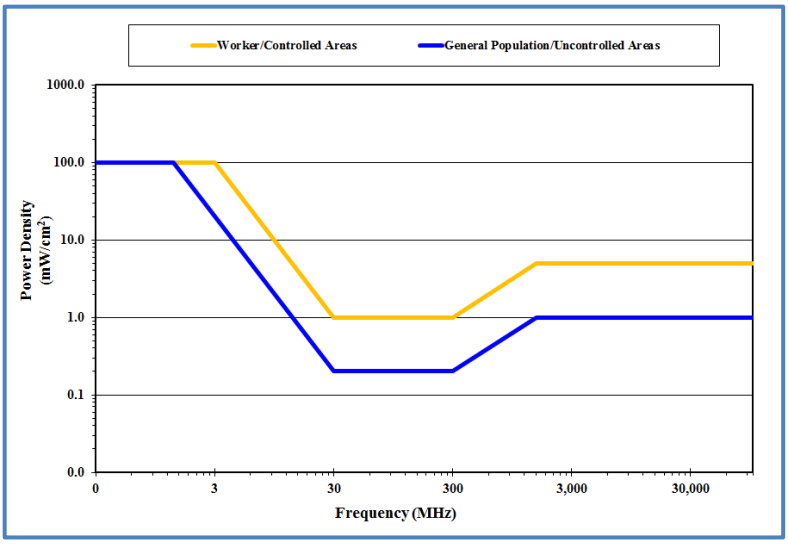


Figure 1: FCC Limits for Maximum Permissible Exposure (MPE)

NOTE: FCC "5% Rule" – When the exposure limits are exceeded in an accessible area due to the emissions from multiple fixed RF sources, actions necessary to bring the area into compliance are the shared responsibility of all licensees whose RF sources produce, at the area in question, levels that exceed 5% of the applicable exposure limit proportional to power. [v]

Figure 2: Location of Proposed Monopole
at 750 Jacobs Road, Montpelier, VT
(Picture courtesy Google Earth®)

OBSERVATIONS IN CONSIDERATION WITH FCC RULES §1.1307(B) & §1.1310

Will it be physically possible to stand next to or touch any omnidirectional antenna and/or stand in front of a directional antenna?

NO; access to the proposed monopole is restricted, and the site will adhere to established RF safety guidelines regarding the transmitting antennas, including the appropriate signage.

THEORETICAL RF FIELD CALCULATIONS - GROUND LEVELS

METHODOLOGY

These calculations are based on what are called "worst-case" estimates. That is, the estimates assume 100% use of all transmitters simultaneously. For these calculations, the surrounding area was assumed to be a flat plane. Note that any loss along the horizontal direction was neglected which means the results would be the maximum values in any direction. The resultant values are thus conservative in that they over-predict actual resultant power densities. The data used to prepare the theoretical RF field calculations are outlined in Table 2 for the proposed AT&T Mobility transmitters.

The calculations are based on the following information:

1. **Effective Radiated Power (ERP):** See Table 2 and Appendix A data).
2. **Antenna Height (Centerline, Above Ground Level (AGL)**: Simple trigonometry was used to determine the resultant "RANGE" and the antenna depression angles.
3. **Antenna Vertical Energy Patterns**: The source of the negative gain (G) values, see Appendix B. Omni-directional antennas are designed to send out relatively equal power in all directions. "Directional" antennas are designed to focus the RF signal, resulting in "patterns" of signal loss and gain. Antenna vertical energy patterns display the loss of signal strength relative to the direction of propagation due to elevation angle changes.

The magnitude of the RF field (the power density (S)) from an isotropic RF source is calculated making use of the power density formula as outlined in FCC's OET Bulletin 65, Edition 97-01: [vi]

$$S = \frac{P \cdot G}{4 \cdot \pi \cdot R^2}$$

Where:

$P \rightarrow$ Power to antenna (Watts)

$G \rightarrow$ Gain of antenna

$R \rightarrow$ Distance (range) from antenna source to point of intersection with the ground (feet)

$R^2 = (\text{Height})^2 + (\text{Horizontal distance})^2$

Since: $P \cdot G = EIRP$ (Effective Isotropic Radiated Power), and for the situation of off-axis power density calculations, apply the negative elevation gain (G^E) value from the vertical energy patterns with the following formula:

$$S = \frac{EIRP \cdot G^E}{4 \cdot \pi \cdot R^2}$$

Ground reflections may add in-phase with the direct wave, and essentially double the electric field intensity. Because power density is proportional to the *square* of the electric field, the power density may quadruple, that is, increase by a factor of four (4).

Since ERP is routinely used, convert ERP into EIRP by multiplying by the factor of 1.64 (the gain of a ½-wave dipole relative to an isotropic radiator).

$$S = \frac{4 \cdot (ERP \cdot 1.64) \cdot G^E}{4 \cdot \pi \cdot R^2} = \frac{ERP \cdot 1.64 \cdot G^E}{\pi \cdot R^2} = \frac{0.522 \cdot ERP \cdot G^E}{R^2}$$

To calculate the % MPE, use the formula:

$$\%\ MPE = \frac{S}{MPE} \cdot 100$$

THEORETICAL RF FIELD CALCULATIONS - DATA

Table 2: Transmitter and Antenna Data and Supporting Parameters for *Proposed* AT&T Mobility PWS Site on the Proposed Monopole; 750 Jacobs Road, Montpelier, VT						
Remote Radio Head Unit (RRH or RRU; See Appendix A)			**Antenna See Appendix B for Energy Patterns**			
Model	Frequency (MHz)[†]/ Technology	# Tx X Output Power (Watts)[‡]	Manufacturer/ Model	Gain (dBd)	**ERP** (Watts)[⁂]	Centerline Height ('AGL)
Sector A @ 0 º Azimuth						
RRUS-4478	720 / LTE-700	4 X 40	KMW EPBQ-654L8H8-L2	15.5	5,677	136'
RRUS-8843	2130 / AWS-2100	4 X 60		18.1	15,496	
RRUS-4449	720 / LTE-700	1 X 60	KMW EPBQ-654L8H8-L2	15.5	2,129	136'
RRUS-4449	850 / ERLTE-850	1 X 60		16.1	2,444	
RRUS-8843	1930 / PCS	4 X 40		17.5	8,997	
Sector B @ 140 º Azimuth						
RRUS-4478	720 / LTE-700	4 X 40	KMW EPBQ-654L8H8-L2	15.5	5,677	136'
RRUS-8843	2130 / AWS-2100	4 X 60		18.1	15,496	
RRUS-4449	720 / LTE-700	1 X 60	KMW EPBQ-654L8H8-L2	15.5	2,129	136'
RRUS-49	850 / ERLTE-850	1 X 60		16.1	2,444	
RRUS-8843	1930 / PCS	4 X 40		17.5	8,997	
Sector C @ 240 º Azimuth						
RRUS-4478	720 / LTE-700	4 X 40	KMW EPBQ-654L8H8-L2	15.5	5,677	136'
RRUS-8843	2130 / AWS-2100	4 X 60		18.1	15,496	
RRUS-4449	720 / LTE-700	1 X 60	KMW EPBQ-654L8H8-L2	15.5	2,129	136'
RRUS-4449	850 / ERLTE-850	1 X 60		16.1	2,444	
RRUS-8843	1930 / PCS	4 X 40		17.5	8,997	

Table Notes

[†] Transmitter (Tx) Frequency: Central transmit frequency used to account for multiple channels.

[‡] Maximum rated output power (per channel).

[⁂] **ERP**: Effective Radiated Power is the directional (RF) power (in Watts) that would have to be radiated by a half-wave dipole antenna to give the same radiation intensity as the actual source at a distant receiver located in the direction of the antenna's strongest beam (main lobe). ERP measures the combination of the power emitted by the transmitter and the ability of the antenna to direct that power in a given direction. It is equal to the input power to the antenna multiplied by the gain of the antenna. (Source Wiki).

Personal Wireless Services (PWS) Technologies

AWS: Advanced Wireless Services
CDMA: Code Division Multiple Access (a.k.a. "Cellular")
LTE: Long Term Evolution (a.k.a. "4G")
ERLTE: Extended Range LTE (600 MHz).
PCS: Personal Communication System
UMTS: Universal Mobile Telecommunications Services
WCS: Wireless Communication Service

RESULTS

The results of the theoretical Cumulative Maximum Percent MPE - vs. - Distance calculations are shown in Figure 3 for the proposed AT&T Mobility PWS transmitters. The values have been plotted against linear distance from the base of the proposed monopole, representing the highest possible values in any direction. The values have been calculated for a height of six feet above ground level in accordance with regulatory rationale. Values for 16' AGL have also been calculated to represent values on the top floor of a typical two-story structure. Note that a logarithmic scale was used to plot the calculated values in order to compare with the MPE of 100%, which is so much larger that it would be off the page in a linear plot.

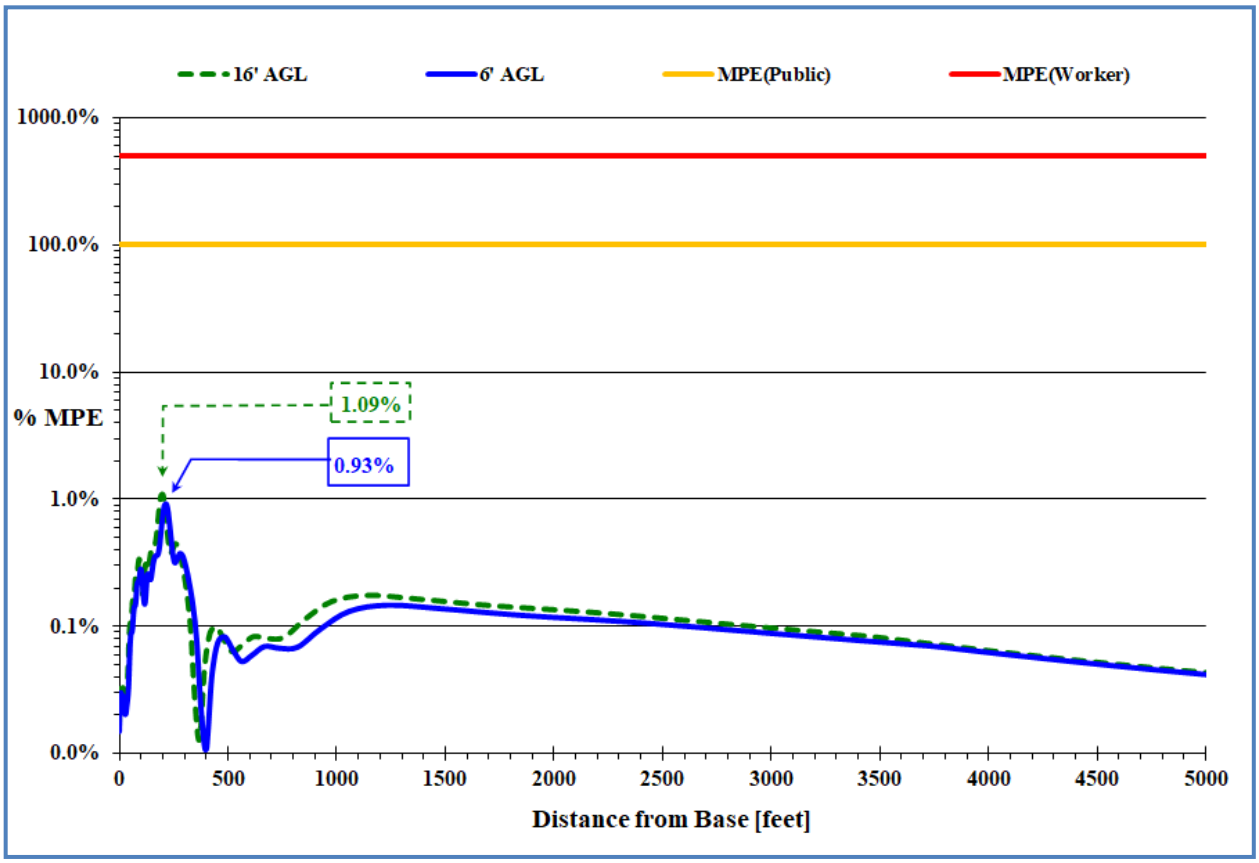


Figure 3: Theoretical Cumulative Maximum Percent MPE - vs. - Distance
Highest Values at Ground Level in Any Direction
For the Proposed AT&T Mobility PWS Transmitters
750 Jacobs Road, Montpelier, VT

CONCLUSION

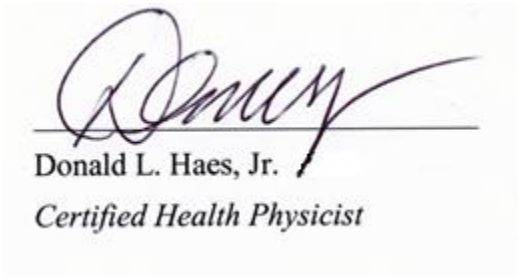
This report is intended to provide written evidence that RF fields from the proposed AT&T Mobility PWS facility on the ground would comply with the FCC RF exposure guidelines. The resulting data indicate the summation of the proposed AT&T Mobility PWS RF contributions would be within the established RF exposure guidelines in all accessible areas on the ground (see Figure 3). **The results support compliance with the pertinent sections of the FCC's guidelines for RF exposure.**

The number and duration of calls passing through PWS facilities cannot be accurately predicted. Thus, to estimate the highest RF fields possible from operation of these installations, the maximal amount of usage was considered. Even in this so-called "worst-case," the resultant increase in RF field levels are far below established levels considered safe.

Based on the results of the theoretical RF fields I have calculated, it is my expert opinion that this facility would comply with all regulatory guidelines for RF exposure with the proposed AT&T Mobility antenna and transmitter installation.

Feel free to contact me if you have any questions.

Sincerely,



Donald L. Haes, Jr.
Certified Health Physicist

DONALD L. HAES, JR., CHP, CLSO

Radiation Safety Specialist

PO Box 198, Hampstead, NH 03841 617-680-6262 Email: donald_haes_chp@comcast.net

STATEMENT OF CERTIFICATION

1. I certify to the best of my knowledge and belief, the statements of fact contained in this report are true and correct.

2. The reported analyses, opinions, and conclusions are limited only by the reported assumptions and limiting conditions, and are personal, unbiased professional analyses, opinions and conclusions.

3. I have no present or prospective interest in the property that is the subject of this report and I have no personal interest or bias with respect to the parties involved.

4. My compensation is not contingent upon the reporting of a predetermined energy level or direction in energy level that favors the cause of the client, the amount of energy level estimate, the attainment of a stipulated result, or the occurrence of a subsequent event.

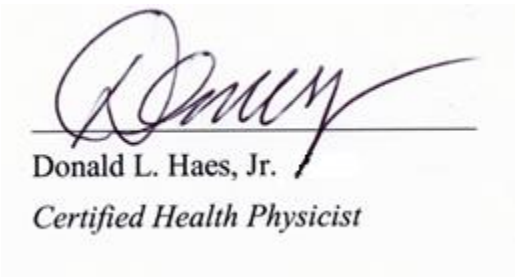
5. This assignment was not based on a requested minimum environmental energy level or specific power density.

6. My compensation is not contingent on an action or event resulting from the analyses, opinions, or conclusions in, or the use of, this report.

7. The consultant has accepted this assessment assignment having the knowledge and experience necessary to complete the assignment competently.

8. My analyses, opinions, and conclusions were developed and this report has been prepared, in conformity with the *American Board of Health Physics* (ABHP) statements of standards of professional responsibility for Certified Health Physicists.

Date: September 16, 2020



DONALD L. HAES, JR., CHP, CLSO

Radiation Safety Specialist

PO Box 198, Hampstead, NH 03841 617-680-6262 Email: donald_haes_chp@comcast.net

SUMMARY OF QUALIFICATIONS

- **Academic Training -**
  - Graduated from Chelmsford High School, Chelmsford, MA; June 1973.
  - Completed Naval Nuclear Naval Nuclear Power School, 6-12/1976.
  - Completed Naval Nuclear Reactor Plant Mechanical Operator and Engineering Laboratory Technician (ELT) schools and qualifications, Prototype Training Unit, Knolls Atomic Power Laboratory, Windsor, Connecticut, 1-9/1977.
  - Graduated Magna Cum Laude from University of Lowell with a Bachelor of Science Degree in *Radiological Health Physics*; 5/1987.
  - Graduated from University of Lowell with a Master of Science Degree in *Radiological Sciences and Protection*; 5/1988.

- **Certification -**
  - Board Certified by the American Board of Health Physics 1994; renewed 1998, 2002, 2006, 2010, 2014, and 2018. Expiration 12/31/2022.
  - Board Certified by the Board of Laser Safety 2008; renewed 2011, 2014, 2017. Expiration 12/31/2020.

- **Employment History -**
  - Consulting Health Physicist; Ionizing/Nonionizing Radiation, 1988 - present.
  - Radiation, RF and Laser Safety Officer; BAE Systems, 2005–2018 (retired).
  - Assistant Radiation Safety Officer; MIT, 1988 – 2005 (retired).
  - Radiopharmaceutical Production Supervisor - DuPont/NEN, 1981 – 1988 (retired).
  - United States Navy; Nuclear Power Qualifications, 1975 – 1981 (Honorably Discharged).

- **Professional Societies -**
  - Health Physics Society [HPS].
  - American Academy of Health Physics [AAHP]
  - Institute of Electrical and Electronics Engineers [IEEE];
  - International Committee on Electromagnetic Safety [ICES] (ANSI C95 series).
  - Laser Institute of America [LIA].
  - Board of Laser Safety [BLS].
  - American National Standards Institute Accredited Standards Committee [ASC Z136].
  - Committee on Man and Radiation [COMAR].

APPENDIX A
SPECIFIC REMOTE RADIO HEAD UNIT: RADIO 4478

RI.
SE

REPORT

Date 2017-06-29 | Reference 7P04388-P90 | Page 5 (72)

Description of the test object

Equipment:	Radio equipment Radio 4478 B14 Product number KRC 161 669/3 FCC ID: TA8AKRC161669-3
Hardware revision state:	R1B
Tested configuration:	Single RAT LTE
Frequency bands: 3GPP B7:	TX: 758 – 768 MHz RX: 788 – 798 MHz
IBW:	10 MHz
Output power:	Max 40 W/ antenna port
Antenna ports:	4 TX / 4 RX ports
Antenna:	No dedicated antenna, handled during licensing
RF configurations:	Single and multi-carrier, 1-2 carriers/ port TX Diversity, 2x2 MIMO, 4x4 MIMO, Contiguous Spectrum (CS), Carrier Aggregation (CA)
Channel bandwidths:	5 MHz and 10 MHz
Modulations:	QPSK, 16QAM, 64QAM and 256QAM
RF power Tolerance:	+0.6/ -2.0 dB
CPRI Speed	Up to 10.1 Gbit/s

The information above is supplied by the manufacturer.

Receipt date	November 15, 2017
Nemko sample ID number	None

3.2 EUT information

Product name	Radio 4449
Model	Radio 4449 B5 B13
Part number	KRC 161 749/1
Revision	R1A
Serial number	B440591478
Antenna ports	4 TX/RX Ports
RF BW / IBW	B5: 25 MHz B13: 10 MHz
FDD	B5: 45 MHz B13: 31 MHz
B5 Frequency range	TX (DL): 869–894 MHz RX (UL): 824–849 MHz
B13 Frequency range	TX (DL): 746–756 MHz RX (UL): 777–787 MHz
Nominal O/P per antenna port	Config 1: B5: Single Carrier, Ports A through D: 1 × 40 W (46 dBm) Config 1: B13: Single Carrier, Ports A through D: 1 × 40 W (46 dBm) Config 2: B5: Single Carrier, Ports A and D: 1 × 60W (47.78 dBm) Config 2: B13: Single Carrier, Ports A and D: 1 × 60W (47.78 dBm)
Accuracy (nominal)	±0.1 ppm
Nominal voltage	2 × –48 V_{DC} @ 20 A
RAT	LTE: SC, MIMO
Modulation	LTE: QPSK, 16 QAM, 64 QAM, 256QAM
Channel bandwidth	LTE: 5 MHz (B5), 10 MHz (B13)
Maximum combined OBW per port	15 MHz
CPRI	10 Gbps
Channel raster	LTE: 100 kHz
Regulatory requirements	Radio: FCC Part 2, 22, 27 EMC: FCC Part 15, ICES-003 Safety: IEC/EN 62368-1, UL/CSA 62368-1 IEC/EN 60950-22, IEC/EN 60529, UL 50E
Emission Designator:	5M00W7D (B5), 10M0W7D (B13)
Supported Configuration	SC, MC, Single Antenna, TX Diversity, MIMO, Carrier Aggregation
Operating temperature	–40 °C to +55 °C
Total Power based on IBW	Config 1: 4 × 40 W (B5) + 4 × 40 W (B13) Config 2: 2 × 60 W (B5) + 2 × 60 W (B13)
Supported carrier / port	LTE BW, B5: 5 (1-3), 10 (1-2); LTE BW, B13: 5 (2), 10 (1)
Optional Fan Tray	N/A

Description of the test object

Equipment:	Radio equipment Radio 8843 B2 B66A Product number KRC 161 707/2 and KRC 161 707/1 FCC ID: TA8AKRC161707-2
Hardware revision state:	R1B (KRC 161 707/2) R2A (KRC 161 707/1)
Tested configuration:	Single RAT LTE
Frequency bands: 3GPP	B2: TX: 1930 – 1990 MHz RX: 1850 – 1910 MHz B66: TX: 2110 – 2180 MHz RX: 1710 – 1780 MHz
IBW:	B2: 60 MHz B66A: 70 MHz
Output power:	Maximum output power: B2: 40 W/ port (port A,B,C,D) 60 W/ port (port A,D) port B and C not used in this configuration B66A: 60 W/ port (port E,F,G,H) 80 W/ port (port E,H) port F and G not used in this configuration.
Antenna ports B2:	A-D: 4 TX / 4 RX ports
Antenna ports B66A:	E-H: 4 TX / 4 RX ports
Antenna:	No dedicated antenna, handled during licensing
RF configurations:	Single and multi-carrier, 1-3 carriers/ port TX Diversity, 2x2 MIMO, 4x4 MIMO, Non-Contiguous Spectrum (NCS), Contiguous Spectrum (CS), Carrier Aggregation (CA) intra-band and inter-band supported

APPENDIX B

ANTENNA ENERGY PATTERNS

AT&T MOBILITY *PROPOSED* KMW EPBQ-654L8H8-L2

KMW COMMUNICATIONS

AIR INTERFACE SOLUTIONS

DualPhase™ 2-way, 3-Sector Antenna With Electrical Down Tilt & Beam Steering

EP-BQ-65-4L-H8

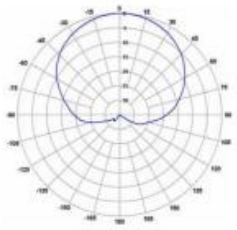
3-Sector 1710 ~ 2170MHz, X-pol., H65° / V7.5°

Electrical Specification

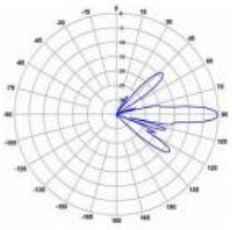
Frequency Range		1710–1880MHz	1850–1990MHz	1920–2170MHz
Gain		17.0 dBi	17.2 dBi	17.5 dBi
Beam Width	Horizontal	67°	65°	63°
	Vertical	7.8°	7.5°	7.2°
Impendance		50Ω		
VSWR		≤1.4:1		
Polarization		Dual, Slant ±45°		
Upper 1st Sidelobe Suppression		≥18 dB (@ downtilt 0°)		
Front-to-Back Ratio		≥30 dB		
Adjustable Downtilt Range		0° – 15°		
Horizontal Beam Steering		-30° – 30°		
Port-to-port Isolation		≥30 dB		
Passive Intermodulation, IM3		≤ -150dBc		
Input Maximum CW Power		250 W		
Control Interface		Feeder Line through Bias-T		

Mechanical Specification

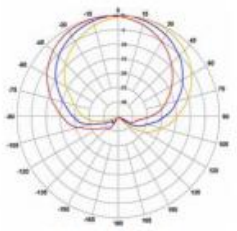
Dimension (Diameter×H)	256×1219mm (10.08×48inch)
Weight (Without Clamp)	22 kg (45.50 lb)
Connector	6 × 7/16° Din(F) / Bottom
Radome Material	FRP
Max Wind Speed	60m/s (135mph)
Wind Load (@ 100mph)	71.80 lbf (319.25 N)



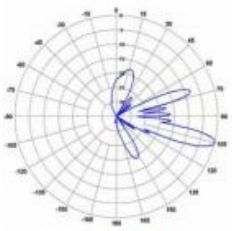
Horizontal Pattern



Vertical Pattern (Downtilt 0°)



Horizontal Beam Steering



Vertical Pattern (Downtilt 15°)

ENDNOTES

[i]. Federal Register, Federal Communications Commission Rules; *Radiofrequency radiation; environmental effects evaluation guidelines* Volume 1, No. 153, 41006-41199, August 7, 1996. (47 CFR Part 1; Federal Communications Commission).

[ii]. Telecommunications Act of 1996, 47 USC; Second Session of the 104th Congress of the United States of America, January 3, 1996.

[iii]. IEEE C95.1-1999: American National Standard, *Safety levels with respect to human exposure to radio frequency electromagnetic fields, from 3 kHz to 300 GHz* **(Updated in 2020)**.

[iv]. National Council on Radiation Protection and Measurements (NCRP); *Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields*, NCRP Report 86, 1986.

[v]. Federal Register, Federal Communications Commission Rules; Vol. 85, No. 63 / Wednesday, April 1, 2020 / Rules and Regulations 18145.

[vi]. OET Bulletin 65: Federal Communications Commission Office of Engineering and Technology, *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields*; Edition 97-01, August 1999.