DONALD L. HAES, JR., CHP

Radiation Safety Specialist

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

January 31, 2024

RE: Installation of a proposed Verizon Wireless personal wireless services facility to be located at 511 Sagamore Road, Rye, NH.

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 Verizon Wireless proposes installing a Personal Wireless Services (PWS) facility including a monopole-styled tower at 511 Sagamore Road, Rye, NH. The PWS antennas are proposed to be at 131 feet above ground level (AGL), centerline. The proposed antenna installations consist of directional panel antennas mounted on in an "array," with four arrays directed along a different azimuth: specifically, 30°, 145°, 210°, and 280°.

This report considers the contributions of ALL the Verizon Wireless' antennas operating at their FCC-licensed capacities. The calculated values of RF fields are presented as a percent of current Maximum Permissible Exposures (%MPE) as adopted by the Federal Communications Commission (FCC).[i,ii]

SUMMARY

Theoretical RF field calculations data indicate the summation of Verizon Wireless' PWS RF contributions would be within the established RF exposure guidelines (See Figures 4a – 4d). This includes all publicly accessible areas, and the neighborhood in general. The results support compliance with the pertinent sections of the FCC's guidelines for RF exposure. Broadband measurements of existing ambient RF field values at several nearby locations indicate the values to be well below the limits for RF exposure to members of the general public as set by the FCC, see Tables 3 and 4. These RF field measurements are accurate, and meet the FCC guidelines.

Based on the results of the theoretical RF field calculations and measured existing ambient RF fields, it is my expert opinion that this facility would comply with all regulatory guidelines for RF exposure with Verizon Wireless' PWS antennas.

Note: The analyses, conclusions and professional opinions are based upon the precise parameters and conditions of this particular site; **Monopole at 511 Sagamore Road, Rye, NH**. 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.

INTRODUCTORY INFORMATION: MAKING SENSE OF THE "G"S

There are many references to the so-called "generation" of wireless technologies in use. Each new "generation" of wireless technologies has colloquially been designated a numbered "G."[1] The latest "G" to come out, the fifth generation of wireless technologies or so called "5G", has attracted extensive research interest, both inside and outside the scientific community. According to the 3rd generation partnership project,[2] 5G networks should support three major families of applications: (1) Enhanced mobile broadband; (2) Machine type communications, and (3) Ultra-reliable and low-latency communications. These situations require much more "connectivity" than the latest fourth generation (aka "4G" or "Long Term Evolution (LTE)") networks can handle. Thus, new networks must be able to handle this high system throughput, in addition to supporting existing older technologies still in use. This is being accomplished through additional spectrum assignments both higher and lower than currently assigned frequencies used by PWS facilities. In fact, currently deployed 5G networks are operating at frequencies once used by television stations.

Nonetheless, frequencies assigned by the FCC for 5G use are all within the bands currently under regulatory oversight, including setting safe limits of exposure to RF energy for both workers, and members of the public. Just recently (4/2020) the FCC has reaffirmed the efficacy of their regulatory exposure limits to RF energy; including those for 5G. On another note, the premiere journal on matters associated with radiation safety (The Health Physics Journal) has released an article on 5G: IEEE Committee on Man and Radiation—COMAR Technical Information Statement: Health and Safety Issues Concerning Exposure of the General Public to Electromagnetic Energy from 5G Wireless Communications Networks; Bushberg, J.T.; Chou, C.-K.; Foster, K.R.; Kavet, R.; Maxson, D.P.; Tell, R.A.; Ziskin, M.C.

From an RF safety standpoint, there is nothing peculiar about the fifth generation of wireless technologies that would set it apart from any of the other advancements of technologies; including the first two generations (first analog then digital communications), the third generation (the first to be referred to a numbered-series as "3G"), and the currently deployed fourth generations (LTE). Recently published studies in peer-reviewed journals[iii] have shown typical exposures to RF energy from operating 5G systems to be well-within the exposure limits.

The FCC currently has categories of devices operating in the Citizens Broadband Radio Service (CBRS) 3.5 GHz band. Category A refers to a lower power base station, while B and C refer to CBSDs that must be deployed outdoors and have increasingly higher maximum power limits.

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[1] PWS "Generations": **1G**: Analog voice; **2G**: Digital voice; **3G**: Mobile data; **4G**: LTE and mobile Internet; **5G**: Mobile networks interconnect people, control machines, and devices with multi-Gbps peak rates & low latency.

[2] SOURCE: (https://www.3gpp.org/about-3gpp) The 3rd Generation Partnership Project (3GPP) unites [Seven] telecommunications standard development organizations (ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, TTC), known as "Organizational Partners" and provides their members with a stable environment to produce the Reports and Specifications that define 3GPP technologies.

EXPOSURE LIMITS AND GUIDELINES

RF exposure guidelines enforced by the FCC were established by the Institute of Electrical and Electronics Engineers (IEEE)[iv] and the National Council on Radiation Protection and Measurement (NCRP).[v] 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. The applicable exposure limits for workers (the "controlled area") are five times higher but averaged over any 6-minute period.

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

Frequency Bands	Maximum Permissible Exposure (MPE) in Equivalent Power Density
300 - 1500 MHz	*f*/1500 mW/cm^2
1500 - 100,000 MHz	1.0 mW/cm^2

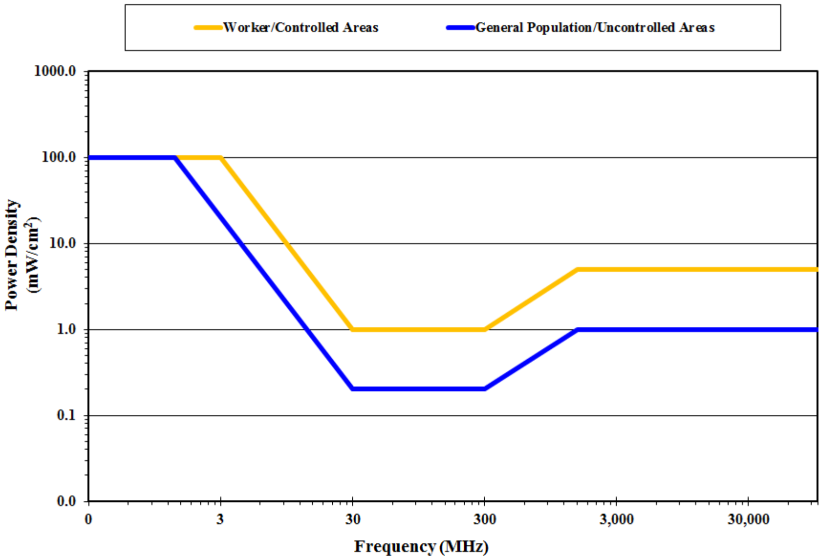


Figure 1: FCC Limits for Maximum Permissible Exposure (MPE)

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. (Federal Register / Vol. 85, No. 63 / Wednesday, April 1, 2020 / Rules and Regulations 18145)

PROPOSED SITE TOPOGRAPHICAL CONDITIONS

The physical conditions are that Verizon Wireless proposes to install a Personal Wireless Services (PWS) facility including a monopole-styled tower at 511 Sagamore Road, Rye, NH (See Figure 2). Verizon Wireless has proposed installing their PWS antennas at 131 feet centerline above ground level (AGL). The proposed antenna installations consist of three directional panel antennas mounted in each array, with each of the four arrays to be directed along a different azimuth: 30°, 145°, 210°, and 280°.

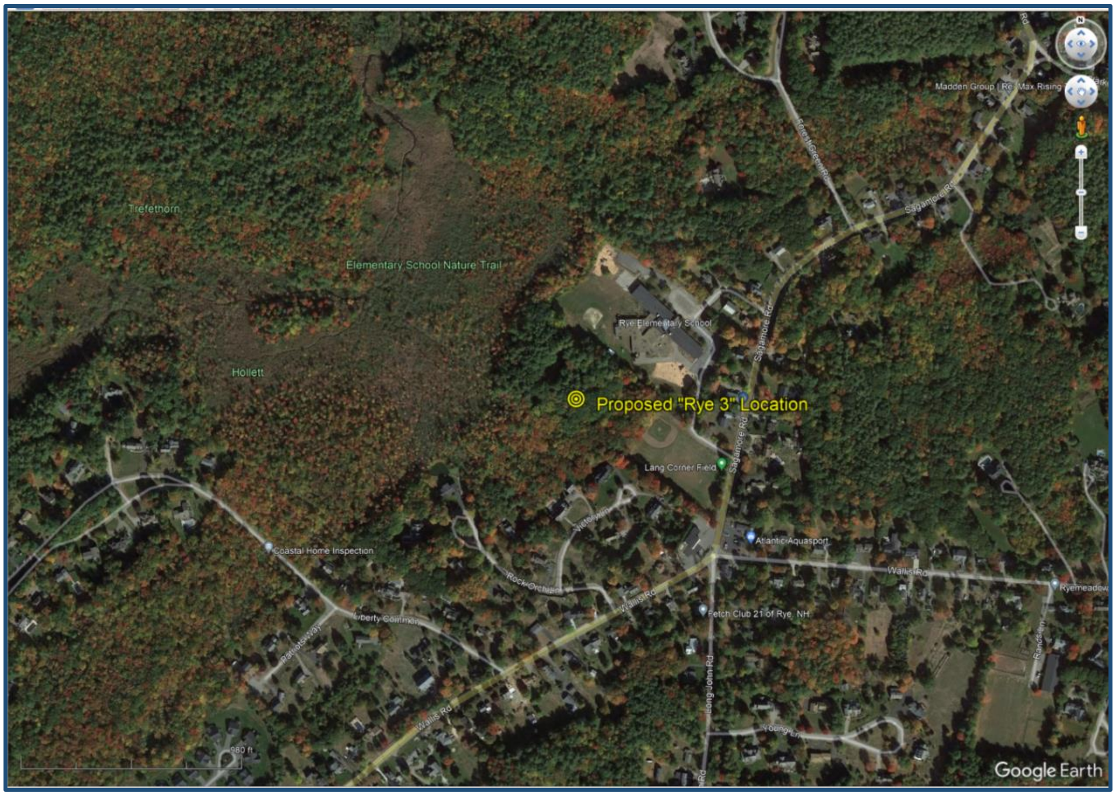


Figure 2: Approximate Location of Proposed PWS Facility
511 Sagamore Road, Rye, NH
(Picture courtesy Google Earth©2024 and may not represent current conditions)

The elevation profile for each array was reviewed with topographical mapping tools to ascertain the terrain. Each elevation profile was mapped along approximately 5,000 feet with the resulting topography noted. See Figures 3a – 3d for the 30°, 145°, 210°, and 280° azimuths, respectively.

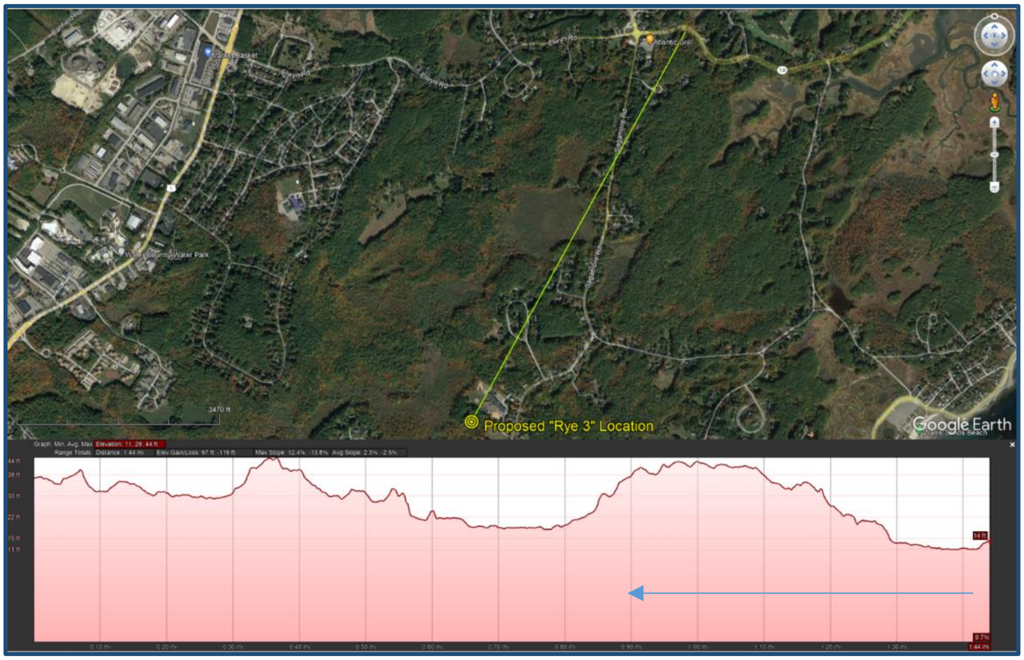
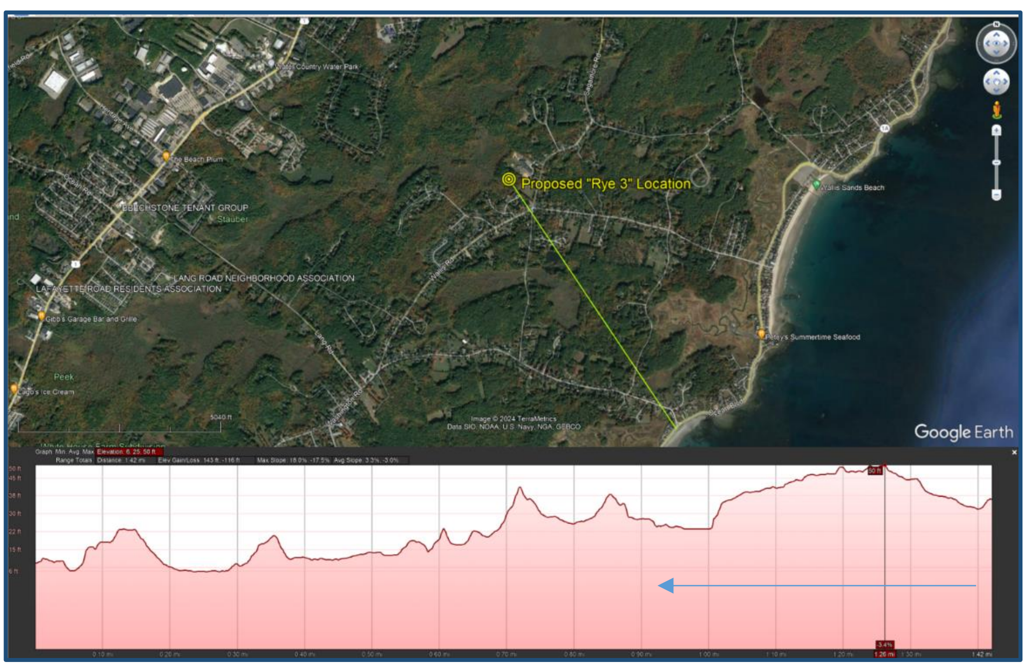
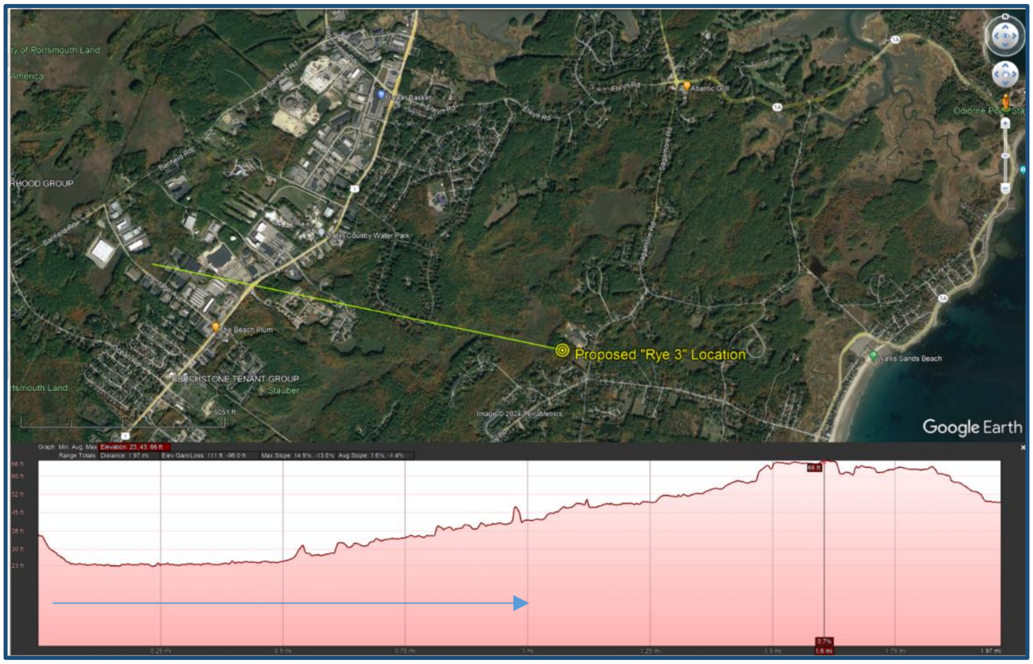


Figure 3a:USGS Elevation Profile Along the 30° ("Alpha") Sector
511 Sagamore Road, Rye, NH
(Picture courtesy Google Earth©2024 and may not represent current conditions)



3b:USGS Elevation Profile Along the 145° ("Beta") Sector
511 Sagamore Road, Rye, NH
(Picture courtesy Google Earth©2024 and may not represent current conditions)

Figure 3c:USGS Elevation Profile Along the 210° ("Gamma") Sector
511 Sagamore Road, Rye, NH
(Picture courtesy Google Earth©2024 and may not represent current conditions)



3d:USGS Elevation Profile Along the 280° ("Delta") Sector
511 Sagamore Road, Rye, NH
(Picture courtesy Google Earth©2024 and may not represent current conditions)

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. Additionally, the calculations account for the electronic "steering" of the antennas in the vertical direction (referred to as "down-tilt") of a modest -5°, and the topography of the surrounding terrain. The resultant values are thus conservative in that they over predict actual resultant power densities. Note that the calculations disregard the curvature of the earth.

The calculations are based on the following information (See Table 2 data):

1. Effective Radiated Power (ERP).
2. Antenna height (Centerline, above ground level (AGL)).
3. Antenna vertical energy patterns; the source of the negative gain (G) values. "Directional" antennas are designed to focus the RF signal, resulting in "patterns" of signal loss and gain. Antenna energy patterns display the loss of signal strength relative to the direction of propagation due to elevation angle changes. The gain is expressed as "G^{E}".

   Note: "G" is a unitless factor usually expressed in decibels (dB); where $G = 10^{(dB/10)}$
   For example: for an antenna *gain* of 3 dB, the net factor $(G) = 10^{(3/10)} = 2$
   For an antenna *loss* of -3 dB, the net factor $(G) = 10^{(-3/10)} = 0.5$

To determine 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 → Power to antenna (watts)
G → Gain of antenna
R → Distance (range) from antenna source to point of intersection with the ground (feet)
$R^2 = (\text{Height})^2 + (\text{Horizontal distance})^2$

Since: P · G = EIRP (Effective Isotropic Radiated Power) for broadcast antennas, the equation can be presented in the following form:

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

In 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, it is necessary to convert ERP into EIRP by multiplying by the factor of 1.64 (the gain of a half-wave dipole relative to an isotropic radiator). Therefore, downrange power density estimates can be calculated by using the formula:

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

To calculate the % MPE, use the formula:

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

The results of the calculations for the potential RF emissions resulting from the summation of the proposed Verizon Wireless PWS antennas are depicted as plotted against linear distance from the base of the monopole for each of the four sectors separately in Figures 4a – 4d. Note that the values have been calculated for a height of 6’ AGL in accordance with regulatory rationale. The calculated theoretical %MPE values are plotted in comparison to the FCC MPE of 100% for continuous exposure to members of the general public. The resultant curve is variable due to the application of the vertical energy patterns. **Log-linear scales** were chosen to plot the resulting values to demonstrate the variability of the RF fields due to antenna energy patterns, distance, and topography.

The results of the calculations for the potential RF emissions resulting from the summation of the proposed Verizon Wireless PWS antennas along the Delta Sector (280°) are similarly depicted adding human exposure limit *(field values that could result in)* 4 W/kg specific absorption rate), in addition to the FCC MPE for continuous exposure to workers (5 time the general public limit). The resultant values are plotted on an **entirely liner scale** to demonstrate the relative value of the possible maximum resulting RF exposure.

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 monopole will be restricted, and the site will adhere to RF safety guidelines regarding the PWS antennas, including appropriate signage.

ANTENNA INVENTORY

Table 2: Verizon Wireless Antenna Inventory; Monopole at 511 Sagamore Road, Rye, NH			
Antenna Centerline (AGL)	Typical Antenna	Parameters: ERP (Watts) Total; Carrier Center Frequency	Proposed Technology
Proposed Verizon Wireless PWS Installation; Alpha Sector at 30° Azimuth			
131’	CommScope NHH-45C-R2B	6111 W; 750 MHz 6670 W; 850 MHz 6670 W; 850 MHz 9443 W; 1950 MHz 10212 W; 2100 MHz	LTE_700 4G_850 5GNR_850 PCS_LTE AWS
Proposed Verizon Wireless PWS Installation; Beta Sector at 145° Azimuth			
131’	CommScope NHH-45C-R2B	6111 W; 750 MHz 6670 W; 850 MHz 6670 W; 850 MHz 9443 W; 1950 MHz 10212 W; 2100 MHz	LTE_700 4G_850 5GNR_850 PCS_LTE AWS
Proposed Verizon Wireless PWS Installation; Gamma Sector at 210° Azimuth			
131’	CommScope NHH-45C-R2B	6111 W; 750 MHz 6670 W; 850 MHz 6670 W; 850 MHz 9443 W; 1950 MHz 10212 W; 2100 MHz	LTE_700 4G_850 5GNR_850 PCS_LTE AWS
Proposed Verizon Wireless PWS Installation; Delta Sector at 280° Azimuth			
131’	CCI Products HPA03R-BWW-H6	4356 W; 750 MHz 4356 W; 850 MHz 4356 W; 850 MHz 7747 W; 1950 MHz 4356 W; 2100 MHz	LTE_700 4G_850 5GNR_850 PCS_LTE AWS

Table Notes:

5GNR: Fifth Generation, “New Radio”
AWS: Advanced Wireless Systems
LTE : Long Term Evolution (aka “4G”)
PCS: Personal Communication System

RESULTS OF THEORETICAL RF FIELD CALCULATIONS

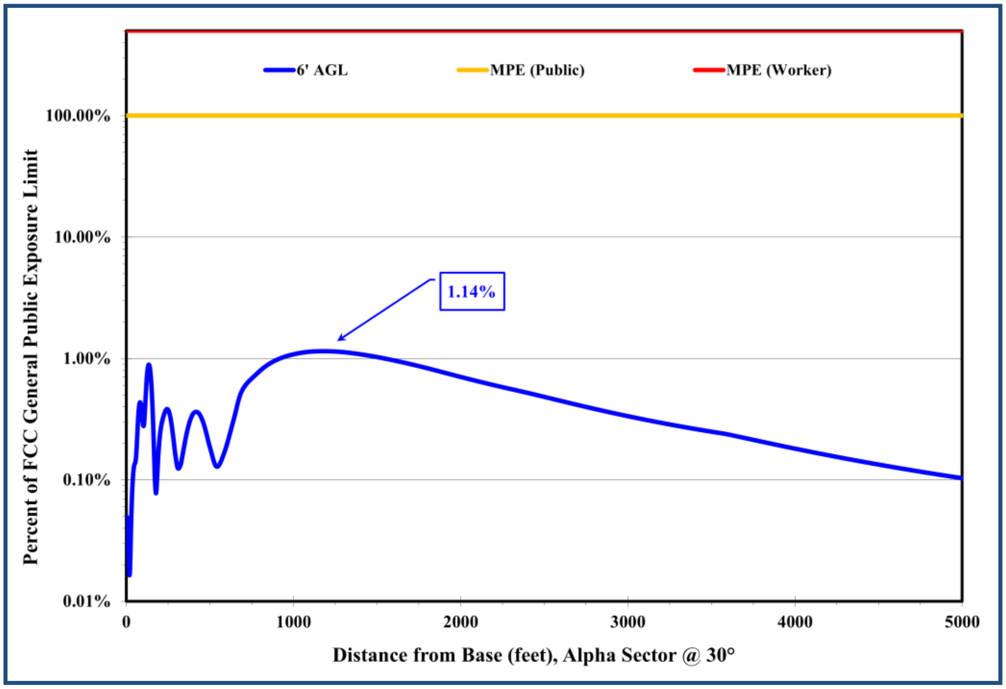


Figure 4a: Theoretical Cumulative Maximum Percent MPE - vs. – Distance Summation of Verizon Wireless PWS RF Contributions Along the 30° ("Alpha" Sector)

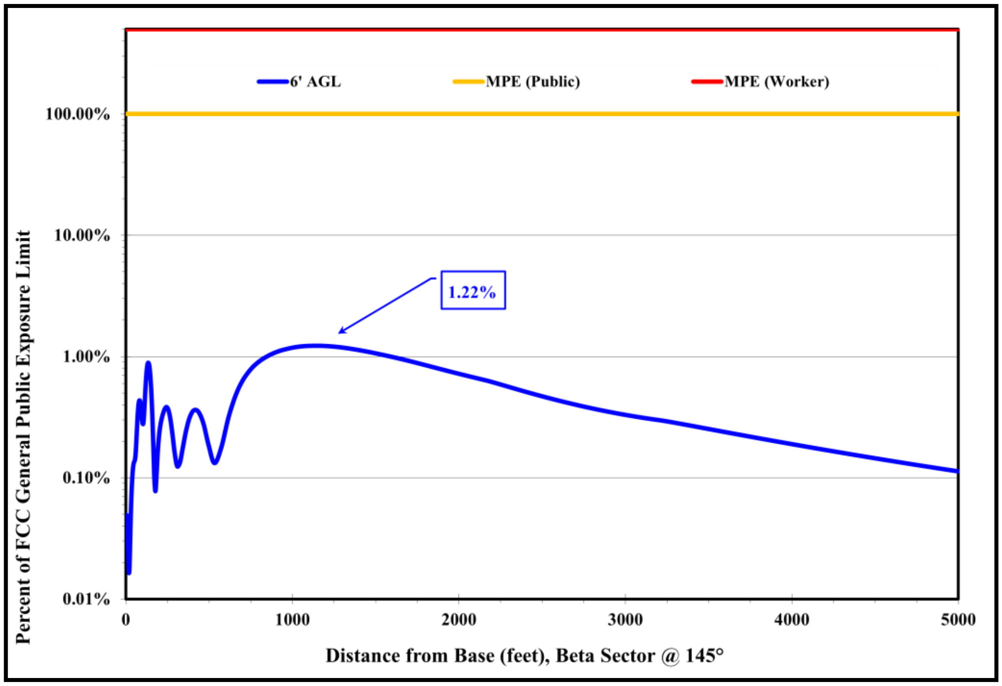


Figure 4b: Theoretical Cumulative Maximum Percent MPE - vs. – Distance Summation of Verizon Wireless PWS RF Contributions Along the 145° ("Beta" Sector)

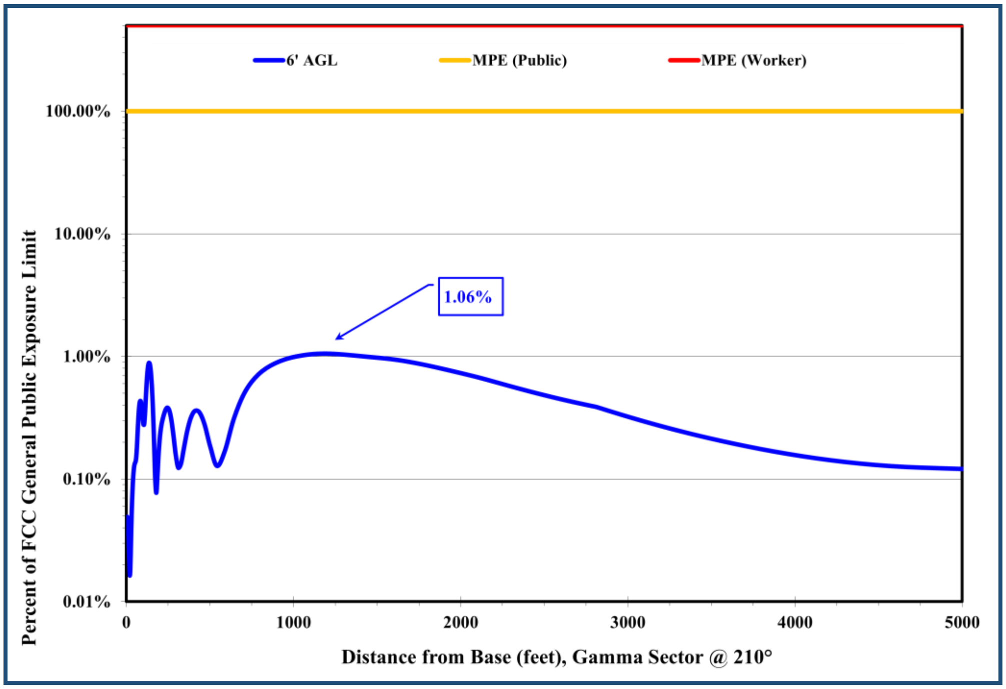


Figure 4c: Theoretical Cumulative Maximum Percent MPE - vs. – Distance Summation of Verizon Wireless PWS RF Contributions Along the 210° ("Gamma" Sector)

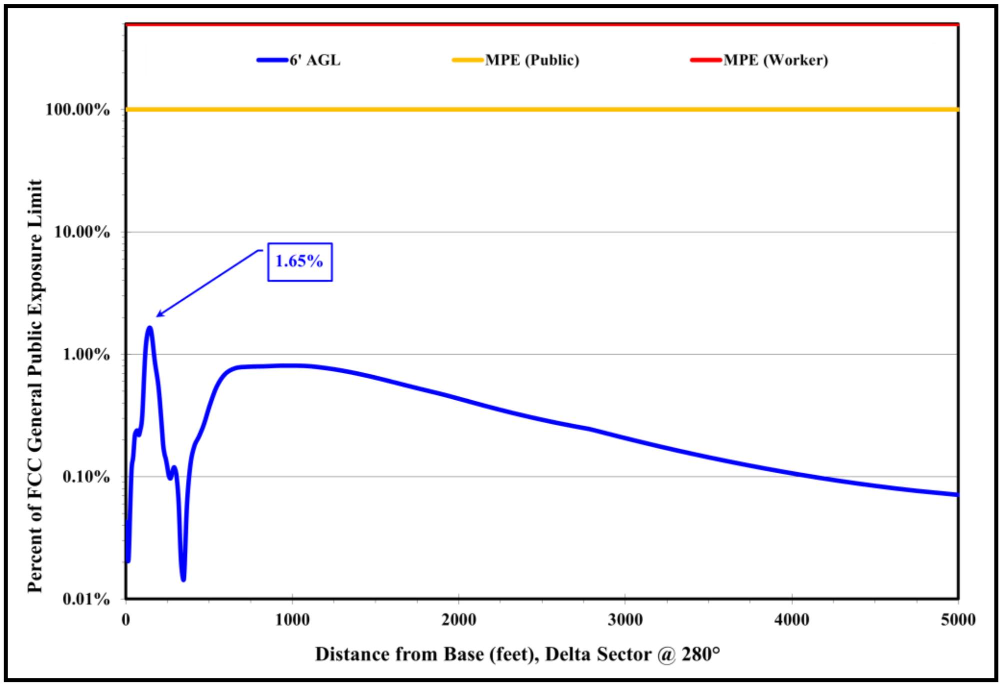


Figure 4d: Theoretical Cumulative Maximum Percent MPE - vs. – Distance Summation of Verizon Wireless PWS RF Contributions Along the 280° ("Delta" Sector)

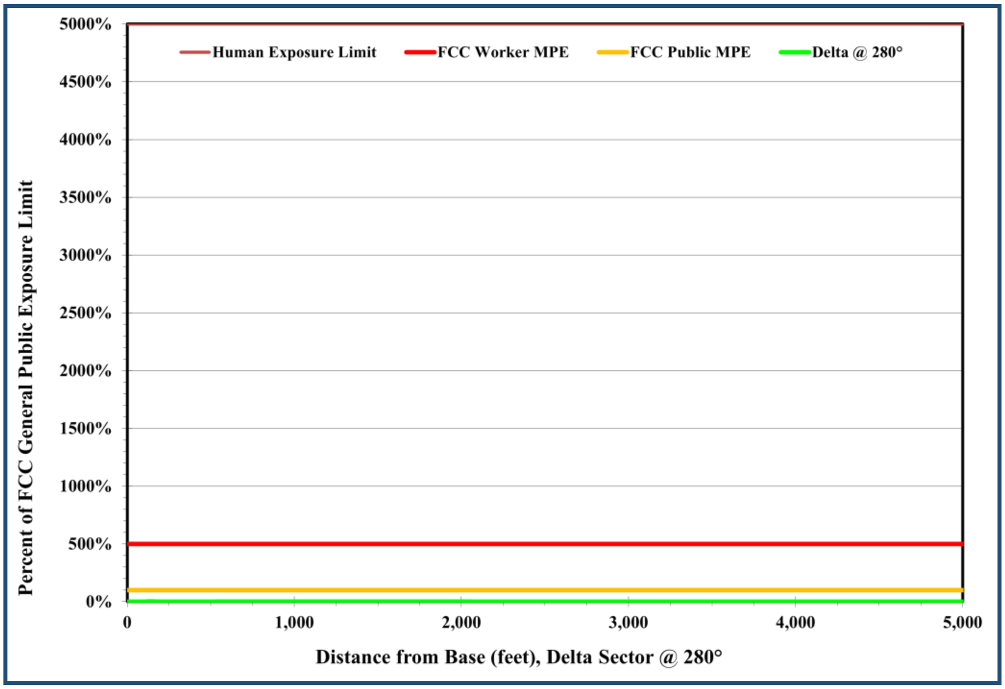


Figure 5: Theoretical Cumulative Maximum Percent MPE - vs. – Distance
Summation of Verizon Wireless PWS RF Contributions Along the 280° ("Delta" Sector)

AMBIENT RF FIELD MEASUREMENT PROTOCOL

RF ambient field measurements were obtained on January 31, 2024, using accepted scientific procedures.[vii, viii] During the survey, the following environmental conditions were noted: Cloudy skies; Temperature 29-32°F; Humidity 55%; Winds 6 NE. The measuring equipment included the following:

- WaveControl Electromagnetic Field Meter SMP with model WPF60S Broadband Isotropic probe, calibrated from 1 MHz to 60,000 MHz.
- The instrumentation was last calibrated on 9/1/2023 by the manufacturer (see Appendix B).
- The WaveControl SMP with model WPF60S probe provides a meter read-out in %MPE (percent FCC 1997 Maximum Permissible Exposure) **for members of the general public** within the frequency band of 1 MHz to 60 GHz (**NOTE**: 1 MHz = 1,000,000 cycles per second, and 1 GHz = 1,000,000,000 cycles per second).

The RF field measurements included three parameters of interest:

1. The "**Spatial Average**": Readings were collected during a continuous scan with the probe from the ground plane up to a height of six feet above ground level. The readings collected were then averaged. The Spatial Average readings at each location were recorded in units of %MPE for members of the public, and are contained in Table 3. See sample data, Appendix C. Note that the minimum and maximum values were also recorded during the scan.
2. The "Peak Field": The highest recorded values obtained during the "Spatial Average" scan. The highest observed readings at each location were recorded in units of %MPE for members of the public, listed as the "maximum reading", and are contained in Table 3. See sample data, Appendix C.
3. The "Time-Averaged" RF Field: The probe was mounted 1.5 meters above the ground on a dielectric tripod. Readings were collected during a continuous time. The readings, collected to observe any variability, were then averaged. The sliding time average readings at location #1 were recorded in units of %MPE for members of the public, and are contained in Table 4.

   NOTE: The accuracy of the measurement system is $\pm$ 1.80 dB (1.515 - 0.661). **The final values are the observed readings multiplied by 1.515 to account for any uncertainty.**

AMBIENT RF FIELD MEASUREMENT LOCATIONS

The locations chosen to obtain the ambient RF field measurement locations are depicted in Figure 6. The criteria for inclusion included repeatable locations based on GPS identification, and represented at least two different locations along each sector, and within approximately 500m (1640') of the proposed monopole base.

Figure 6: Numbered Locations of RF Field Measurements
Proposed PWS Facility to be Located At
511 Sagamore Road, Rye, NH

Note: Red circle indicates 500m (1640') radius from the proposed monopole base.
Green lines indicate directions of azimuth for each of the four sectors.
(Picture courtesy Google Earth©2024 and may not represent current conditions)

Table 3: Results of Spatial Average Broadband RF Field Measurements In Units of Percent of FCC General Public Limits, 1-60,000 MHz Locations in the General Vicinity of the Proposed Monopole to be Located at 511 Sagamore Road, Rye, NH				
Survey Location, See Figure 6	**Minimum Reading**	**Maximum Reading**	**Spatial Average Reading**	**Spatial Average Reading**
Number	Observed (% MPE)†	Observed (% MPE)†	Observed (% MPE)†	**Corrected (% MPE)** ‡
1	0.01612	0.02319	0.01966	**0.02978**
2	0.0213	0.02659	0.02335	**0.03538**
3	0.005914	0.009422	0.007935	**0.01202**
4	0.0165	0.01734	0.01694	**0.02566**
5	0.02187	0.02369	0.02267	**0.03435**
6	0.02302	0.02798	0.02505	**0.03795**
7	0.01381	0.02346	0.01882	**0.02851**
8	0.01638	0.02231	0.01974	**0.02991**
9	0.009784	0.0172	0.01319	**0.01998**
10	0.01152	0.01905	0.01459	**0.02210**

Table Notes:
† Observed meter readings in percent FCC Maximum Permissible Exposure (MPE) for the general public.

‡ Readings multiplied by 1.515 to correct for instrument uncertainty.

Table 4: Results of Time-Averaged Broadband RF Field Measurements In Units of Percent of FCC General Public Limits, 1-60,000 MHz Locations in the General Vicinity of the Proposed Monopole to be Located at 511 Sagamore Road, Rye, NH				
Survey Location, See Figure 6	**Minimum Reading**	**Maximum Reading**	**Time-Averaged Reading**	**Time-Averaged Reading**
Number	Observed (% MPE)†	Observed (% MPE)†	Observed (% MPE)†	**Corrected (% MPE)** ‡
1	0.002471	0.1121	0.02591	**0.03925**

Table Notes:
† Observed meter readings in percent FCC Maximum Permissible Exposure (MPE) for the general public.

‡ Readings multiplied by 1.515 to correct for instrument uncertainty.

CONCLUSION

Theoretical RF field calculations data indicate the summation of Verizon Wireless' PWS RF contributions would be within the established RF exposure guidelines (See Figures 4a – 4d). This includes all publicly accessible areas, and the neighborhood in general. The results support compliance with the pertinent sections of the FCC's guidelines for RF exposure.

Broadband measurements of existing ambient RF fields levels at several nearby locations indicate the values to be well below the limits for RF exposure to members of the general public as set by the FCC, see Tables 3 and 4. These RF field measurements are accurate, and meet the FCC guidelines.

The number and duration of calls passing through PWS facilities cannot be accurately predicted. Thus, in order 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 is far below established levels considered safe.

Based on the results of the theoretical RF field calculations and measured existing ambient RF fields, it is my expert opinion that this proposed facility would comply with all regulatory guidelines for RF exposure with Verizon Wireless' PWS antennas.

Feel free to contact me if you have any questions.

Sincerely,

Donald L. Haes, Jr.
Certified Health Physicist

Note: The analyses, conclusions and professional opinions are based upon the precise parameters and conditions of this particular site; **Monopole at 511 Sagamore Road, Rye, NH**. 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.

DONALD L. HAES, JR., CHP
Radiation Safety Specialist
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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.

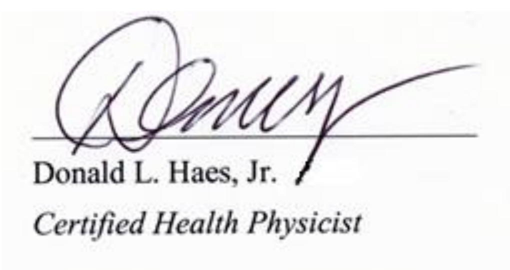
5. This assignment was not based on a requested minimum environmental energy level or specific power density.

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: January 31, 2024



DONALD L. HAES, JR., CHP

Radiation Safety Specialist

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SUMMARY OF QUALIFICATIONS

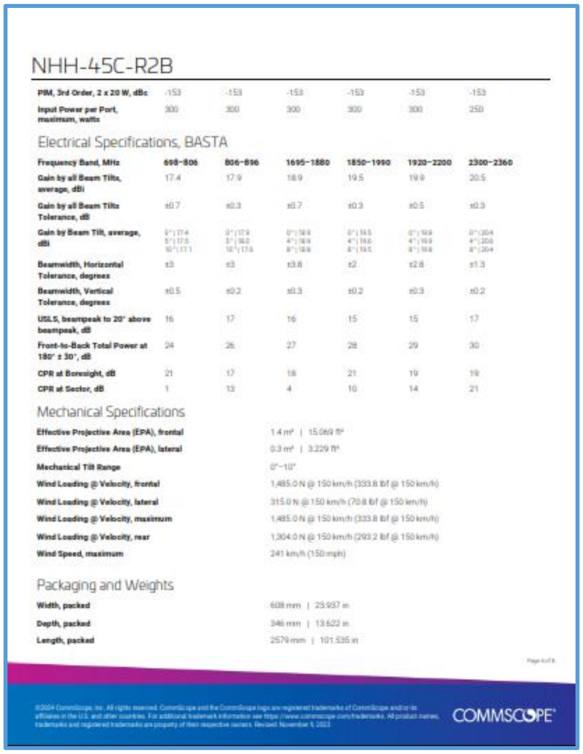
- **Academic Training -**
  - Graduated from Chelmsford High School, Chelmsford, MA; June 1973.
  - Completed Naval Nuclear Naval Nuclear Power School, 6-12/1976.
  - Completed Naval Nuclear Reactor Plant Mechanical Operator and Engineering Laboratory Technician (ELT) schools and qualifications, Prototype 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, 2018, and 2022. Expiration 12/31/2026.
  - Board Certified by the Board of Laser Safety 2008; renewed 2011, 2014, 2017, 2020, 2023. Expiration 12/31/2026.

- **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
TYPICAL PWS DIRECTIONAL PANEL ANTENNAS



NHH-45C-R2B

PIM, 3rd Order, 2 x 20 W, dBc	-153	-153	-153	-153	-153	-153
Input Power per Port, maximum, watts	300	300	300	300	300	250

Electrical Specifications, BASTA

Frequency Band, MHz	698–806	806–896	1695–1880	1850–1990	1920–2200	2300–2360
Gain by all Beam Tilts, average, dBi	17.4	17.9	18.9	19.5	19.9	20.5
Gain by all Beam Tilts Tolerance, dB	±0.7	±0.3	±0.7	±0.3	±0.5	±0.3
Gain by Beam Tilt, average, dBi	0° | 17.4 5° | 17.5 10° | 17.1	0° | 17.9 5° | 18.0 10° | 17.6	0° | 18.9 4° | 18.9 8° | 18.9	0° | 19.5 4° | 19.6 8° | 19.5	0° | 19.8 4° | 19.9 8° | 19.8	0° | 20.4 4° | 20.6 8° | 20.4
Beamwidth, Horizontal Tolerance, degrees	±3	±3	±3.8	±2	±2.8	±1.3
Beamwidth, Vertical Tolerance, degrees	±0.5	±0.2	±0.3	±0.2	±0.3	±0.2
USLS, beampeak to 20° above beampeak, dB	16	17	16	15	15	17
Front-to-Back Total Power at 180° ± 30°, dB	24	26	27	28	29	30
CPR at Boresight, dB	21	17	18	21	19	19
CPR at Sector, dB	1	13	4	10	14	21

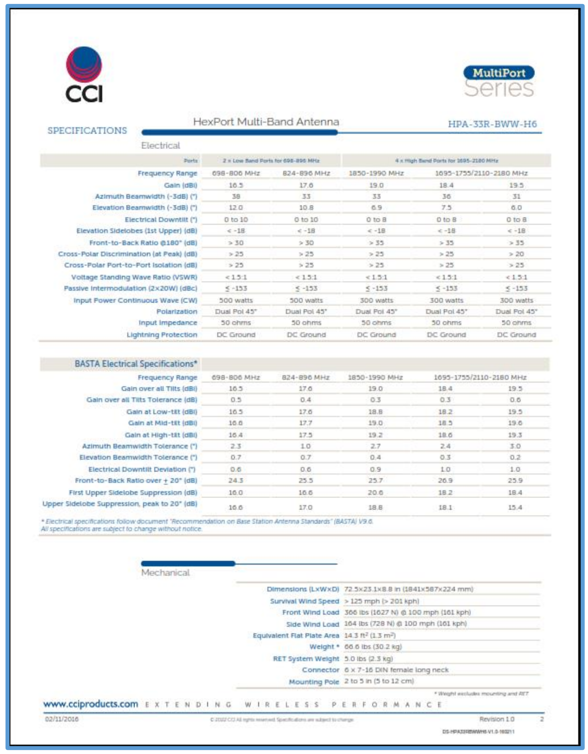
Mechanical Specifications

Effective Projective Area (EPA), frontal	1.4 m² | 15.069 ft²
Effective Projective Area (EPA), lateral	0.3 m² | 3.229 ft²
Mechanical Tilt Range	0°–10°
Wind Loading @ Velocity, frontal	1,485.0 N @ 150 km/h (333.8 lbf @ 150 km/h)
Wind Loading @ Velocity, lateral	315.0 N @ 150 km/h (70.8 lbf @ 150 km/h)
Wind Loading @ Velocity, maximum	1,485.0 N @ 150 km/h (333.8 lbf @ 150 km/h)
Wind Loading @ Velocity, rear	1,304.0 N @ 150 km/h (293.2 lbf @ 150 km/h)
Wind Speed, maximum	241 km/h (150 mph)

Packaging and Weights

Width, packed	608 mm | 23.937 in
Depth, packed	346 mm | 13.622 in
Length, packed	2579 mm | 101.535 in

COMMSCOPE



CCI — MultiPort Series

SPECIFICATIONS — HexPort Multi-Band Antenna — HPA-33R-BWW-H6

Electrical

Ports	2 x Low Band Ports for 698-896 MHz		4 x High Band Ports for 1695-2180 MHz		
Frequency Range	698-806 MHz	824-896 MHz	1850-1990 MHz	1695-1755/2110-2180 MHz	
Gain (dBi)	16.5	17.6	19.0	18.4	19.5
Azimuth Beamwidth (-3dB) (°)	38	33	33	36	31
Elevation Beamwidth (-3dB) (°)	12.0	10.8	6.9	7.5	6.0
Electrical Downtilt (°)	0 to 10	0 to 10	0 to 8	0 to 8	0 to 8
Elevation Sidelobes (1st Upper) (dB)	< -18	< -18	< -18	< -18	< -18
Front-to-Back Ratio @180° (dB)	> 30	> 30	> 35	> 35	> 35
Cross-Polar Discrimination (at Peak) (dB)	> 25	> 25	> 25	> 25	> 20
Cross-Polar Port-to-Port Isolation (dB)	> 25	> 25	> 25	> 25	> 25
Voltage Standing Wave Ratio (VSWR)	< 1.5:1	< 1.5:1	< 1.5:1	< 1.5:1	< 1.5:1
Passive Intermodulation (2x20W) (dBc)	≤ -153	≤ -153	≤ -153	≤ -153	≤ -153
Input Power Continuous Wave (CW)	500 watts	500 watts	300 watts	300 watts	300 watts
Polarization	Dual Pol 45°	Dual Pol 45°	Dual Pol 45°	Dual Pol 45°	Dual Pol 45°
Input Impedance	50 ohms	50 ohms	50 ohms	50 ohms	50 ohms
Lightning Protection	DC Ground	DC Ground	DC Ground	DC Ground	DC Ground

BASTA Electrical Specifications*					
Frequency Range	698-806 MHz	824-896 MHz	1850-1990 MHz	1695-1755/2110-2180 MHz	
Gain over all Tilts (dBi)	16.5	17.6	19.0	18.4	19.5
Gain over all Tilts Tolerance (dB)	0.5	0.4	0.3	0.3	0.6
Gain at Low-tilt (dBi)	16.5	17.6	18.8	18.2	19.5
Gain at Mid-tilt (dBi)	16.6	17.7	19.0	18.5	19.6
Gain at High-tilt (dBi)	16.4	17.5	19.2	18.6	19.3
Azimuth Beamwidth Tolerance (°)	2.3	1.0	2.7	2.4	3.0
Elevation Beamwidth Tolerance (°)	0.7	0.7	0.4	0.3	0.2
Electrical Downtilt Deviation (°)	0.6	0.6	0.9	1.0	1.0
Front-to-Back Ratio over ± 20° (dB)	24.3	25.5	25.7	26.9	25.9
First Upper Sidelobe Suppression (dB)	16.0	16.6	20.6	18.2	18.4
Upper Sidelobe Suppression, peak to 20° (dB)	16.6	17.0	18.8	18.1	15.4

*Electrical specifications follow document "Recommendation on Base Station Antenna Standards" (BASTA) V9.6.
All specifications are subject to change without notice.

Mechanical

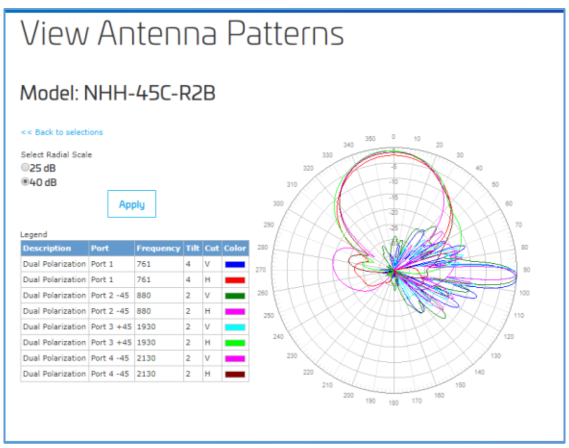
Dimensions (LxWxD)	72.5x23.1x8.8 in (1841x587x224 mm)
Survival Wind Speed	> 125 mph (> 201 kph)
Front Wind Load	366 lbs (1627 N) @ 100 mph (161 kph)
Side Wind Load	164 lbs (728 N) @ 100 mph (161 kph)
Equivalent Flat Plate Area	14.3 ft² (1.3 m²)
Weight *	66.6 lbs (30.2 kg)
RET System Weight	5.0 lbs (2.3 kg)
Connector	6 x 7-16 DIN female long neck
Mounting Pole	2 to 5 in (5 to 12 cm)

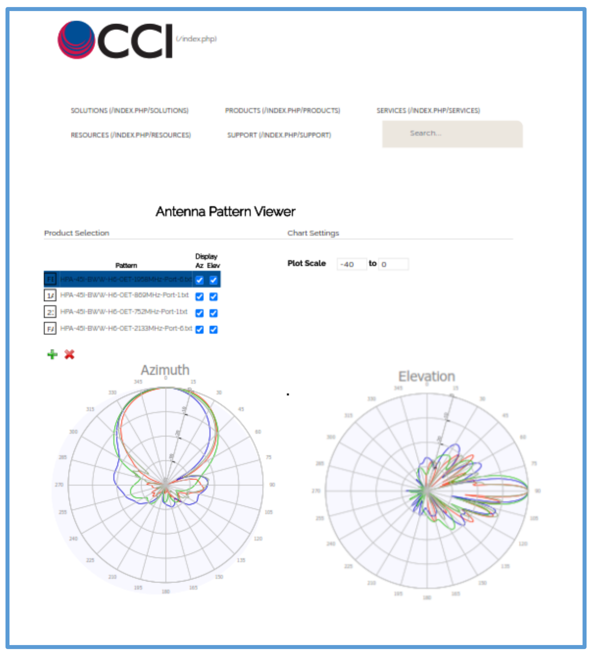
* Weight excludes mounting and RET

www.cciproducts.com EXTENDING WIRELESS PERFORMANCE

02/11/2016 © 2022 CCI All rights reserved. Specifications are subject to change Revision 1.0 2

DS-HPA33RBWWH6-V1.0-160211





APPENDIX B
CALIBRATION CERTIFICATE

CERTIFICATE OF CALIBRATION

Number NE23/02504

Page 1 of 5 pages

LabCal - Wavecontrol
Radio-electric Calibration Laboratory
C/ Pallars 65-71
08018 Barcelona (Spain)

WAVECONTROL

ITEM	EM Field Meter + Isotropic EM Field Probe
BRAND	Wavecontrol
MODEL	Meter: SMP3 Probe: WPF60S
IDENTIFICATION	Probe: 23WP220099
APPLICANT	Wavecontrol Inc. 101 Eisenhower Pkwy Suite 300 Roseland, NJ 07068-1054 USA
DATE/S OF CALIBRATION	1/9/2023

Authorized Signatories: Date of issue: 01/09/2023

David Guayerbas
Laboratory Technician

Laboratory Director

WAVECONTROL

Certificate of Calibration

Page 2 of 5 Number: NE23/02504

Measurement:

The calibration of field strength monitors involves the generation of a known linearly polarised electromagnetic field, approximating to a plane wave, into which the probe or sensor is placed.

Over the frequency range of 1 – 800 MHz, an absorber loaded TEM cell is used to generate the known field. The probe under test is positioned perpendicular to the electric field and parallel to the direction of propagation.

Over the frequency range of 800 MHz – 40 GHz the probe is positioned on a low reflectivity mount inside a microwave anechoic chamber on the bore sight of a linearly polarised horn antenna. The probe under test is always perpendicular to the direction of propagation and parallel to the electric field.

Three calibration parameters are obtained:

1- Correction factor (CF)

For each measurement, the input power to the test facility is adjusted so that the actual field strength is set to a specific value. The field strength indicated by the probe under calibration is then read and the correction factor calculated using the following definition:

$$CF = \frac{Actual\ Field\ Strength}{Indicated\ Field\ Strength} \qquad CF^2 = \frac{Actual\ Power\ Density}{Indicated\ Power\ Density}$$

The indicated field strength must be multiplied by the appropriate correction factor to give the actual field strength.

2- Linearity

The linearity can be calculated as the variation of the Correction Factor as a function of the field strength applied to the probe for a frequency value.

3- Frequency response

The frequency response can be calculated as the variation of the Correction Factor as a function of the frequency for a fixed field value applied to the probe.

Traceability:

NPL (National Physical Laboratory)

WAVECONTROL

Certificate of Calibration

Page 3 of 5 Number: NE23/02504

Reference standards:

IEEE Std 1309:2013 "Standard for Calibration of Electromagnetic Field Sensors and Probes, Excluding Antennas, from 9 kHz to 40 GHz".

Uncertainties:

The uncertainty of calibration for this device is as follows:

1 MHz - 10 MHz:	±	1.61 dB
20 MHz - 300 MHz:	±	1.85 dB
300 MHz – 500 MHz:	±	1.72 dB
500 MHz - 800 MHz:	±	1.89 dB
800 MHz - 1 GHz:	±	1.60 dB
1 GHz - 2.5 GHz:	±	1.60 dB
2.5 GHz - 8 GHz:	±	1.95 dB
8 GHz - 18 GHz:	±	1.95 dB
18 GHz - 40 GHz:	±	2.05 dB

The measurement uncertainties above apply only when the probe is supported in a low reflectivity mount. The user should be aware of the effects of reflections from nearby objects, including human body, and should allow additional measurement uncertainties accordingly.

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor $k = 2$, providing a level of confidence of approximately 95 %. The uncertainty evaluation has been carried out in accordance with the EA-4/02 document.

Environmental conditions:

Humidity	Temperature
(40.0 ± 10,0) % rH	(23.0 ± 2,0) °C

The uncertainties refer to the measured devices only. They relate to the on-the-day values and make no allowance for drift or operation under other environmental conditions.

Procedure:

PC-1205 – Calibration of electric field probes in the range 100 kHz – 800 MHz
PC-1206 – Calibration of electric field probes in the range 800 MHz – 40 GHz

Both methods follow the *Standard probe method*. A reference probe is used to measure and calibrate the field used for calibrating the probe under calibration.

Calibration engineer: David Guayerbas

WAVECONTROL

Certificate of Calibration

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Results:

The correction factors (CF) for the requested calibration points are shown below.

Linearity / Limit: FCC Occup.				
Frequency (MHz)	Field (V/m)	Power Density [% Limit]	Indicated (%)	CF^2
100	1	0.03	0.03	0.94
100	3	0.17	0.17	0.96
100	5	0.66	0.68	0.98
100	10	2.65	2.75	0.96
100	20	10.61	11.17	0.95
100	30	23.87	24.31	0.98
100	40	42.44	45.59	0.93
100	50	66.31	71.98	0.92
100	60	95.49	98.45	0.97
100	80	169.76	176.24	0.96
100	90	214.86	218.27	0.98

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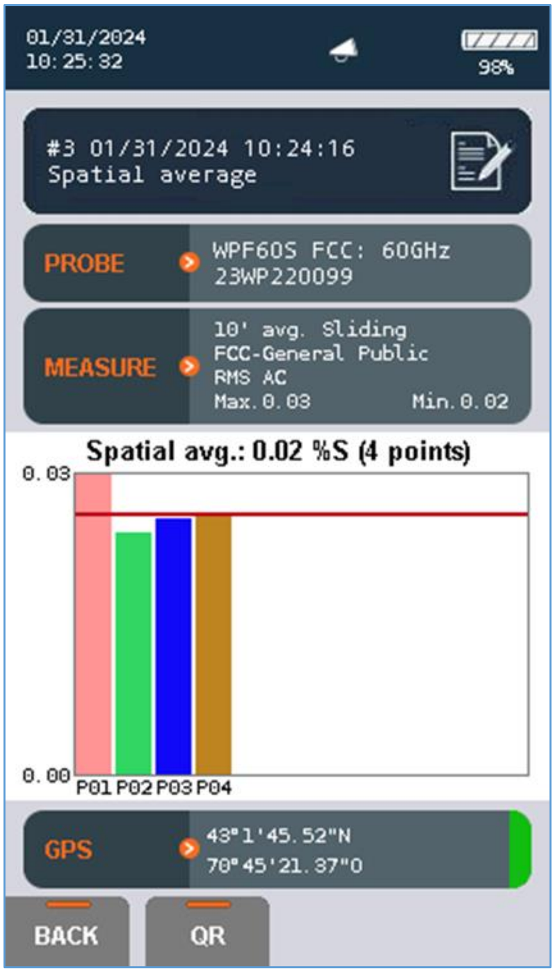
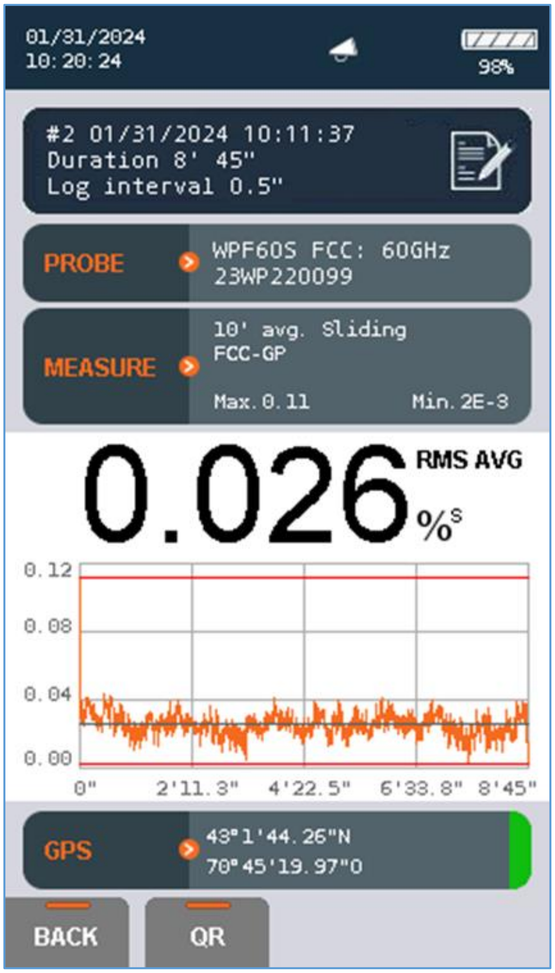
Certificate of Calibration

Page 5 of 5 Number: NE23/02504

Frequency Response / Limit: FCC Occup.				
Frequency (MHz)	Field (V/m)	Power Density [% Limit]	Indicated (%)	CF^2
1	90	2.15	0.60	3.59
10	30.5	2.74	3.24	0.85
30	30.5	24.68	15.89	1.55
100	30.5	24.68	25.23	0.98
200	30.5	24.68	28.93	0.85
400	30.5	18.51	24.14	0.77
600	36.7	17.86	32.04	0.56
700	39.7	17.92	24.43	0.73
800	21.2	4.47	9.78	0.46
1000	23.7	4.47	9.53	0.47
1200	26	4.48	9.15	0.49
1400	28.05	4.47	9.01	0.50
1600	30	4.80	10.34	0.46
1800	31.8	5.39	11.65	0.46
2000	34.25	6.25	13.33	0.47
2200	34.25	6.25	11.81	0.53
2400	34.25	6.25	12.54	0.50
2600	34.25	6.25	12.31	0.51
2800	34.25	6.25	13.61	0.46
3000	34.25	6.25	11.43	0.55
3200	34.25	6.25	11.04	0.57
3400	34.25	6.25	11.29	0.55
3600	34.25	6.25	10.27	0.61
3800	34.25	6.25	8.06	0.78
4000	28.5	4.33	6.15	0.70
5000	28.5	4.33	6.36	0.68
6000	28.5	4.33	5.70	0.76
7000	28.5	4.33	4.98	0.87
8000	28.5	4.33	3.10	1.40
9000	19.55	2.04	1.89	1.08
10000	19.55	2.04	1.08	1.88
12000	19.55	2.04	1.81	1.13
14000	19.55	2.04	3.47	0.59
16000	19.55	2.04	2.36	0.86
18000	19.55	2.04	2.38	0.86
26500	17.5	1.63	1.88	0.87
40000	17.5	1.63	3.06	0.53

APPENDIX C
SAMPLE DATA





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January 29, 2024

Statements from Governments and Expert Panels Concerning Health Effects and Safe Exposure Levels of Radiofrequency Energy (2000-2023)

95. **<u>Bangladesh Telecommunication Regulatory Commission (BTRC) (2023)</u>**

Radiation from mobile towers, sets safe: BTRC
https://bangladeshpost.net/posts/radiation-from-mobile-towers-sets-safe-btrc-128091

- "Radiation that is emitted from mobile handsets and mobile towers across the country poses no harm and the level of radiation is much lower than the safety levels set by the international organizations, according to Bangladesh Telecommunication Regulatory Commission (BTRC)."
- "BTRC carried out a survey on the electromagnetic field (EMF) radiation emitted by mobile phone towers and mobile handsets in nine districts recently where the regulator found nothing harmful to the environment either."
- "The outcomes of that survey unveiled that the radiation emitted by the towers owned by different mobile operators falls within the acceptable limits as determined by the telecommunications regulatory authority."

94. **<u>WHO systematic review on pregnancy and birth outcomes (2023)</u>**

Effects of Radiofrequency Electromagnetic Field (RF-EMF) exposure on pregnancy and birth outcomes: A systematic review of experimental studies on non-human mammals. Cordelli E, Ardoino L, Benassi B, Consales C, Eleuteri P, Marino C, Sciortino M, Villani P, Brinkworth MH, Chen G, McNamee JP, Wood AW, Belackova L, Verbeek J, Pacchierotti F. Environ Int. 108178, 2023.
https://www.sciencedirect.com/science/article/pii/S0160412023004518?via%3Dihub

- "In conclusion, studies on experimental mammals indicate that RF-EMF exposure does not have a detrimental effect on fecundity based on the high level of certainty for results on litter size. There is a moderate certainty that RF-EMF exposure [>5 W/kg] likely affects offspring at birth, based on the meta-analysis of studies on fetal weight. There is a moderate certainty that RF-EMF exposure does not have a delayed effect on the weight of brain or cerebellum after in utero exposure. On the other hand, RF-EMF may have a delayed adverse effect, varying in magnitude on neurobehavioural functions, but these findings are very uncertain. Finally, our results show that RF-EMF exposure of experimental mammals in utero may not have a delayed effect on the fertility of the female offspring [F2]."
- "As a whole, the possible impact of in utero RF-EMF exposure remains uncertain due to the severe limitations [such as lack of "blinding during experiment performance and outcome assessment" and inadequate "exposure characterization"] of some of the studies"
- "Our systematic review … did not provide conclusions certain enough to inform decisions at a regulatory level, but it can be considered a solid starting point to direct future research …."

93. **SCENIHR (Scientific Committee on Emerging and Newly Identified Health Risks) (2023)**

Opinion on the need of a revision of the annexes in the Council Recommendation 1999/519/EC and Directive 2013/35/EU, in view of the latest scientific evidence available with regard to radiofrequency (100kHz – 300GHz)

https://health.ec.europa.eu/system/files/2023-06/scheer_o_044.pdf

- "The Opinion calls for a revision based on new technical data and emerging applications that have become available. No moderate or strong evidence could identify potential adverse health effects at exposure levels below the current recommendation, .."
- "The SCHEER acknowledges that the latest (2020) ICNIRP exposure guidelines introduce new dosimetric quantities to protect humans more effectively from emerging technological applications of RF EMF. Therefore, the SCHEER advises positively on the need of a technical revision of the annexes in Council Recommendation 1999/519/EC and Directive 2013/35/EU with regard to radiofrequency electromagnetic fields (100 kHz to 300 GHz)."

92. **Swedish Radiation Safety Authority's (SSM) (2022)**

Recent Research on EMF and Health Risk, Sixteenth report from SSM's Scientific Council on Electromagnetic Fields

https://www.stralsakerhetsmyndigheten.se/contentassets/e031f45648ed4b438a0535e350863707/2022-16-recent-research-on-emf-and-health-risk.pdf

- "This report reviews studies on electromagnetic fields (EMF) and health risks, published from January 2020 up to and including December 2020."
- "No new established causal relationships between EMF exposure and health risk have been identified."
- "Associations between mobile phone use and insomnia-like symptoms have been observed as in previous years. However, insomnia was associated rather to the time period of use than to the level of radiation exposure. This suggests that other factors than RF-EMF (Radiofrequency-EMF) may explain the observed association. Such factors may include for example stress or other behavioral factors."
- "New studies in adolescent on cognitive functions and brain volume do not indicate a risk from RF-EMF exposure."
- "The annual report also includes a section where studies that lack satisfactory quality have been listed. This year, as well as last year, many studies have been excluded due to poor quality (see appendix). From a scientific perspective, studies of poor quality are irrelevant. They are also a waste of money, human resources and, in many cases, experimental animals."

91. **Nordic countries (2022)**

Time trends in mobile phone use and glioma incidence among males in the Nordic Countries, 1979–2016

https://doi.org/10.1016/j.envint.2022.107487

- "In the Nordic countries, the use of mobile phones increased sharply in the mid-1990s especially among middle-aged men. We investigated time trends in glioma incidence rates (IR) with the perspective to inform about the plausibility of brain tumour risks from mobile phone use reported in some case-control studies."

- "This study confirms and reinforces the conclusions that no changes in glioma incidence in the Nordic countries have occurred that are consistent with a substantial risk attributable to mobile phone use. This particularly applies to virtually all reported risk increases reported by previous case-control studies with positive findings."

90. **New Zealand (2022)**

Trends in brain cancers (glioma) in New Zealand from 1995 to 2020, with reference to mobile phone use

https://doi.org/10.1016/j.canep.2022.102234

- "Hypothesis is that mobile phone use increases brain cancers such as glioma."
- "Mobile phone use in New Zealand increased greatly between 1990 and 2006."
- "Incidence of glioma from 1995 to 2020 showed no increase at ages 10–69."
- "No evidence that phone use increases risk even after many years."
- "There is no indication of any increase related to the use of mobile phones. These results are similar to results in Australia and in many other countries. The increase in recorded incidence at ages over 80 is similar to that seen in other countries and consistent with improved diagnostic methods."

89. **UK Institution of Engineering and Technology (2021)**

Electromagnetic fields and health

https://www.theiet.org/media/9587/electromagnetic-fields-and-health.pdf

- "Mobile phone base stations produce exposure levels that are comparable to or smaller than those from radio and TV antennas. Studies of base stations have not found evidence that risks of childhood cancers are greater in the vicinity of mobile phone masts. In the same vein, studies investigating longer established sources of radio waves, including radio, TV and radar, have not found consistent evidence of health effects."
- "With both frequency bands, some people report a variety of symptoms in relation to quite weak fields, a condition commonly known as electro hypersensitivity. A systematic review of medical research into the condition has found no convincing scientific evidence for the symptoms being caused by EMFs."

88. **Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) (2021)**

New study finds no link between mobile phone use and salivary gland tumours

https://www.arpansa.gov.au/news/new-study-finds-no-link-between-mobile-phone-use-and-salivary-gland-tumours

- "The study looked at the number of parotid and other salivary gland cancers occurring in Australia from 1982 to 2016, which coincides with the rise of mobile phone use among the general population."
- "The 34 years of data analysed in the study does not indicate that mobile phone use has increased the incidence of parotid or other salivary gland cancers."
- "The study did observe a slight increase in parotid gland cancer in females since 2006, however, due to similar radio wave absorption and mobile usage rates for males and females, other factors

specifically related to females may be the cause."

- "The findings of the study remain consistent with the International Commission on Non-Ionizing Radiation Protection (ICNIRP) assessment that exposure to radiofrequency electromagnetic energy within international safety limits has no adverse health effects on the human body."

87. **Swedish Radiation Safety Authority (2021)**
    Research on EMF & Health Risks

https://www.stralsakerhetsmyndigheten.se/en/publications/reports/radiation-protection/2021/202108/

- "No new established causal relationships between EMF exposure and health risks have been identified. New research on brain tumors and mobile phone use is in line with previous research suggesting mostly an absence of risk."
- "The annual report also includes a section where studies that lack satisfactory quality have been listed. This year, as well as last year, many studies have been excluded due to poor quality. From a scientific perspective, studies of poor quality are irrelevant. They are also a waste of money, human resources and, in many cases, experimental animals."
- "The results of the research review give no reason to change any reference levels or recommendations in the field."
- "Despite the fact that no health risks associated with weak electromagnetic fields have been demonstrated up to date, the authority considers that further research is important, in particular regarding long-term effects as more or less the entire population is exposed."

86. **Austrian Scientific Council for Radio Communications (2021)**
    Mobile Communications Do Not Endanger Health

https://futurezone.at/science/mobilfunk-gefaehrdet-die-gesundheit-nicht/401172049

- "Researchers of the interdisciplinary Scientific Advisory Board Funk (WBF) analyzed 130 international scientific studies on the subject of "Mobile communications and health" from the period July 2019 to June 2020."
- "They have shown that there is no connection between electromagnetic radiation and cancer, nor do they have a negative impact on the fertility of men. According to the WBF, the latter is primarily influenced by lifestyle."
- "The conclusion: According to the current state of research, there is no health risk to humans from cell phone radiation."

85. **International Agency for Research on Cancer (2020)**
    World Cancer Report: Cancer research for cancer prevention

https://iarc.who.int/cards_page/world-cancer-report/"

- "Most of the epidemiological research does not support an association between mobile phone use and tumours occurring in the head, which is the body part with the highest exposure to radiofrequency electromagnetic fields. In studies reporting positive associations, it is difficult to exclude various forms of bias, such as recall bias in retrospective exposure assessment."
- "It has been more than 25 years since mobile phones were introduced, and they have been used by billions of people. These facts, combined with the consistent lack of increase in incidence rates in countries with high use of mobile phones, call causality into question."

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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: January 29, 2024