

**Verizon Wireless • Proposed Base Station (Site No. 387975 “South Petaluma”)  
611 Western Avenue • Petaluma, California**

**Statement of Hammett & Edison, Inc., Consulting Engineers**

The firm of Hammett & Edison, Inc., Consulting Engineers, has been retained on behalf of Verizon Wireless, a personal wireless telecommunications carrier, to evaluate the base station (Site No. 387975 “South Petaluma”) proposed to be located at 611 Western Avenue in Petaluma, California, for compliance with appropriate guidelines limiting human exposure to radio frequency (“RF”) electromagnetic fields.

**Executive Summary**

Verizon proposes to install directional panel antennas above the roof of the Petaluma Creamery, located at 611 Western Avenue in Petaluma. The proposed operation will comply with the FCC guidelines limiting public exposure to RF energy; certain measures are recommended to comply with FCC occupational guidelines.

**Prevailing Exposure Standards**

The U.S. Congress requires that the Federal Communications Commission (“FCC”) evaluate its actions for possible significant impact on the environment. A summary of the FCC’s exposure limits is shown in Figure 1. These limits apply for continuous exposures and are intended to provide a prudent margin of safety for all persons, regardless of age, gender, size, or health. The most restrictive FCC limit for exposures of unlimited duration to radio frequency energy for several personal wireless services are as follows:

Wireless Service Band	Transmit Frequency	“Uncontrolled” Public Limit	Occupational Limit (5 times Public)
Microwave (point-to-point)	1–80 GHz	1.0 mW/cm <sup>2</sup>	5.0 mW/cm <sup>2</sup>
Millimeter-wave	24–47	1.0	5.0
Part 15 (WiFi & other unlicensed)	2–6	1.0	5.0
CBRS (Citizens Broadband Radio)	3,550 MHz	1.0	5.0
BRS (Broadband Radio)	2,490	1.0	5.0
WCS (Wireless Communication)	2,305	1.0	5.0
AWS (Advanced Wireless)	2,110	1.0	5.0
PCS (Personal Communication)	1,930	1.0	5.0
Cellular	869	0.58	2.9
SMR (Specialized Mobile Radio)	854	0.57	2.85
700 MHz	716	0.48	2.4
600 MHz	617	0.41	2.05
[most restrictive frequency range]	30–300	0.20	1.0

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**General Facility Requirements**

Base stations typically consist of two distinct parts: the electronic transceivers (also called “radios” or “channels”) that are connected to the traditional wired telephone lines, and the passive antennas that send the wireless signals created by the radios out to be received by individual subscriber units. The transceivers are often located at ground level and are connected to the antennas by coaxial cables. Because of the short wavelength of the frequencies assigned by the FCC for wireless services, the antennas require line-of-sight paths for their signals to propagate well and so are installed at some height above ground. The antennas are designed to concentrate their energy toward the horizon, with very little energy wasted toward the sky or the ground. This means that it is generally not possible for exposure conditions to approach the maximum permissible exposure limits without being physically very near the antennas.

**Computer Modeling Method**

The FCC provides direction for determining compliance in its Office of Engineering and Technology Bulletin No. 65, “Evaluating Compliance with FCC-Specified Guidelines for Human Exposure to Radio Frequency Radiation,” dated August 1997. Figure 2 describes the calculation methodologies, reflecting the facts that a directional antenna’s radiation pattern is not fully formed at locations very close by (the “near-field” effect) and that at greater distances the power level from an energy source decreases with the square of the distance from it (the “inverse square law”). The conservative nature of this method for evaluating exposure conditions has been verified by numerous field tests.

**Site and Facility Description**

Based upon information provided by Verizon, including zoning drawings by MST Architects, Inc., dated September 18, 2020, it is proposed to install sixteen CommScope Model NHH-45B directional panel antennas within four cylindrical enclosures to be mounted above the roof of the tallest building section of the Petaluma Creamery, located at 611 Western Avenue in Petaluma. The antennas would employ up to 13° downtilt, would be mounted at an effective height of about 66½ feet above ground, 6½ feet above the roof, and would be oriented in groups of four toward 0°T, 90°T, 180°T, and 270°T, to provide service in all directions. The maximum effective radiated power in any direction would be 46,800 watts, representing simultaneous operation at 18,350 watts for AWS, 10,000 watts for PCS, 9,940 watts for cellular, and 8,510 watts for 700 MHz service. There are reported no other wireless telecommunications base stations at the site or nearby.



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**Study Results**

For a person anywhere at ground, the maximum RF exposure level due to the proposed Verizon operation is calculated to be  $0.12 \text{ mW/cm}^2$ , which is 22% of the applicable public exposure limit. The maximum calculated level at the second-floor elevation of any nearby building\* is 31% of the public exposure limit. The maximum calculated level at the second-floor elevation of any nearby residence† is 24% of the public limit. It should be noted that these results include several “worst-case” assumptions and therefore are expected to overstate actual power density levels from the proposed operation. Levels are calculated to exceed the applicable exposure limits on the roof of the subject building, in front of the antennas.

**Recommended Mitigation Measures**

It is recommended that the roof access hatch be kept locked, so that the Verizon antennas are not accessible to unauthorized persons. To prevent occupational exposures in excess of the FCC guidelines, it is recommended that appropriate RF safety training, to include review of personal monitor use and lockout/tagout procedures, be provided to all authorized personnel who have access to the roof, including employees and contractors of Verizon and of the property owner. No access within 62 feet directly in front of the Verizon antennas themselves, such as might occur during certain maintenance activities on the roof of the building, should be allowed while the pertinent antennas are in operation, unless other measures can be demonstrated to ensure that occupational protection requirements are met. It is recommended that boundary lines be marked on the roof with yellow and orange paint, to identify areas within which exposure levels are calculated to exceed the FCC occupational limit and to exceed that limit by 10 times, respectively, as shown in Figure 3. It is recommended that explanatory signs‡ be posted at the roof access hatch, at the boundary lines, and on the cylindrical enclosures in front of the antennas, readily visible from any angle of approach to persons who might need to work within that distance.

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\* Specifically, the two-story building to the south across Baker Street, about 100 feet away, based on photographs from Google Maps.

† Specifically, the residences to the northwest across Western Avenue, at least 200 feet away, based on photographs from Google Maps.

‡ Signs should comply with OET-65 color, symbol, and content recommendations. Contact information should be provided (e.g., a telephone number) to arrange for access to restricted areas. The selection of language(s) is not an engineering matter, and guidance from the landlord, local zoning or health authority, or appropriate professionals may be required.

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**Conclusion**

Based on the information and analysis above, it is the undersigned’s professional opinion that operation of the base station proposed by Verizon Wireless at 611 Western Avenue in Petaluma, California, can comply with the prevailing standards for limiting human exposure to radio frequency energy and, therefore, need not for this reason cause a significant impact on the environment. The highest calculated level in publicly accessible areas is much less than the prevailing standards allow for exposures of unlimited duration. This finding is consistent with measurements of actual exposure conditions taken at other operating base stations. Locking the roof access hatch is recommended to establish compliance with public exposure limits; training authorized personnel, marking roof areas, and posting explanatory signs are recommended to establish compliance with occupational exposure limits.

**Authorship**

The undersigned author of this statement is a qualified Professional Engineer, holding California Registration Nos. E-13026 and M-20676, which expire on June 30, 2021. This work has been carried out under his direction, and all statements are true and correct of his own knowledge except, where noted, when data has been supplied by others, which data he believes to be correct.

October 12, 2020



A handwritten signature in blue ink that reads "William F. Hammett".

William F. Hammett, P.E.

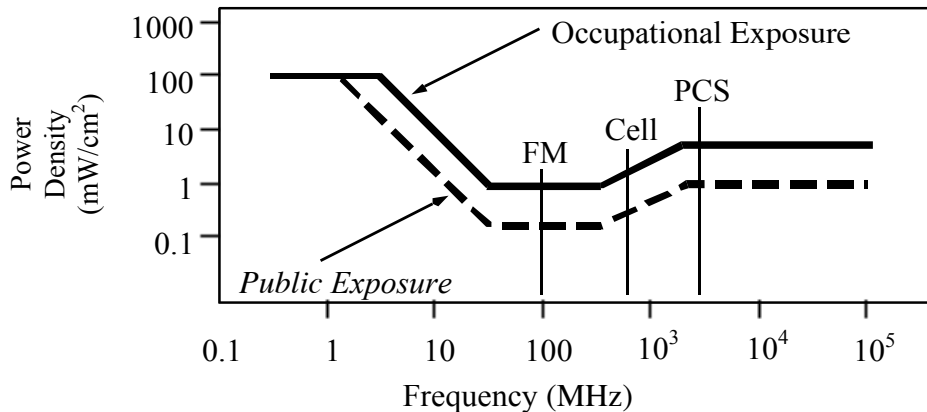
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## FCC Radio Frequency Protection Guide

The U.S. Congress required (1996 Telecom Act) the Federal Communications Commission (“FCC”) to adopt a nationwide human exposure standard to ensure that its licensees do not, cumulatively, have a significant impact on the environment. The FCC adopted the limits from Report No. 86, “Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields,” published in 1986 by the Congressionally chartered National Council on Radiation Protection and Measurements (“NCRP”). Separate limits apply for occupational and public exposure conditions, with the latter limits generally five times more restrictive. The more recent standard, developed by the Institute of Electrical and Electronics Engineers and approved as American National Standard ANSI/IEEE C95.1-2006, “Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz,” includes similar limits. These limits apply for continuous exposures from all sources and are intended to provide a prudent margin of safety for all persons, regardless of age, gender, size, or health.

As shown in the table and chart below, separate limits apply for occupational and public exposure conditions, with the latter limits (in *italics* and/or dashed) up to five times more restrictive:

Frequency Applicable Range (MHz)	Electromagnetic Fields (f is frequency of emission in MHz)					
	Electric Field Strength (V/m)		Magnetic Field Strength (A/m)		Equivalent Far-Field Power Density (mW/cm <sup>2</sup> )	
0.3 – 1.34	614	<i>614</i>	1.63	<i>1.63</i>	100	<i>100</i>
1.34 – 3.0	614	<i>823.8/f</i>	1.63	<i>2.19/f</i>	100	<i>180/f<sup>2</sup></i>
3.0 – 30	1842/f	<i>823.8/f</i>	4.89/f	<i>2.19/f</i>	900/f <sup>2</sup>	<i>180/f<sup>2</sup></i>
30 – 300	61.4	<i>27.5</i>	0.163	<i>0.0729</i>	1.0	<i>0.2</i>
300 – 1,500	3.54√f	<i>1.59√f</i>	√f/106	<i>√f/238</i>	f/300	<i>f/1500</i>
1,500 – 100,000	137	<i>61.4</i>	0.364	<i>0.163</i>	5.0	<i>1.0</i>



Higher levels are allowed for short periods of time, such that total exposure levels averaged over six or thirty minutes, for occupational or public settings, respectively, do not exceed the limits, and higher levels also are allowed for exposures to small areas, such that the spatially averaged levels do not exceed the limits. However, neither of these allowances is incorporated in the conservative calculation formulas in the FCC Office of Engineering and Technology Bulletin No. 65 (August 1997) for projecting field levels. Hammett & Edison has incorporated those formulas in a computer program capable of calculating, at thousands of locations on an arbitrary grid, the total expected power density from any number of individual radio frequency sources. The program allows for the inclusion of uneven terrain in the vicinity, as well as any number of nearby buildings of varying heights, to obtain more accurate projections.



## RFR.CALC™ Calculation Methodology

### Assessment by Calculation of Compliance with FCC Exposure Guidelines

The U.S. Congress required (1996 Telecom Act) the Federal Communications Commission (“FCC”) to adopt a nationwide human exposure standard to ensure that its licensees do not, cumulatively, have a significant impact on the environment. The maximum permissible exposure limits adopted by the FCC (see Figure 1) apply for continuous exposures from all sources and are intended to provide a prudent margin of safety for all persons, regardless of age, gender, size, or health. Higher levels are allowed for short periods of time, such that total exposure levels averaged over six or thirty minutes, for occupational or public settings, respectively, do not exceed the limits.

#### Near Field.

Prediction methods have been developed for the near field zone of panel (directional) and whip (omnidirectional) antennas, typical at wireless telecommunications base stations, as well as dish (aperture) antennas, typically used for microwave links. The antenna patterns are not fully formed in the near field at these antennas, and the FCC Office of Engineering and Technology Bulletin No. 65 (August 1997) gives suitable formulas for calculating power density within such zones.

For a panel or whip antenna, power density  $S = \frac{180}{\theta_{BW}} \times \frac{0.1 \times P_{net}}{\pi \times D \times h}$ , in mW/cm<sup>2</sup>,

and for an aperture antenna, maximum power density  $S_{max} = \frac{0.1 \times 16 \times \eta \times P_{net}}{\pi \times h^2}$ , in mW/cm<sup>2</sup>,

where  $\theta_{BW}$  = half-power beamwidth of antenna, in degrees,

$P_{net}$  = net power input to antenna, in watts,

$D$  = distance from antenna, in meters,

$h$  = aperture height of antenna, in meters, and

$\eta$  = aperture efficiency (unitless, typically 0.5-0.8).

The factor of 0.1 in the numerators converts to the desired units of power density.

#### Far Field.

OET-65 gives this formula for calculating power density in the far field of an individual RF source:

power density  $S = \frac{2.56 \times 1.64 \times 100 \times RFF^2 \times ERP}{4 \times \pi \times D^2}$ , in mW/cm<sup>2</sup>,

where  $ERP$  = total ERP (all polarizations), in kilowatts,

$RFF$  = three-dimensional relative field factor toward point of calculation, and

$D$  = distance from antenna effective height to point of calculation, in meters.

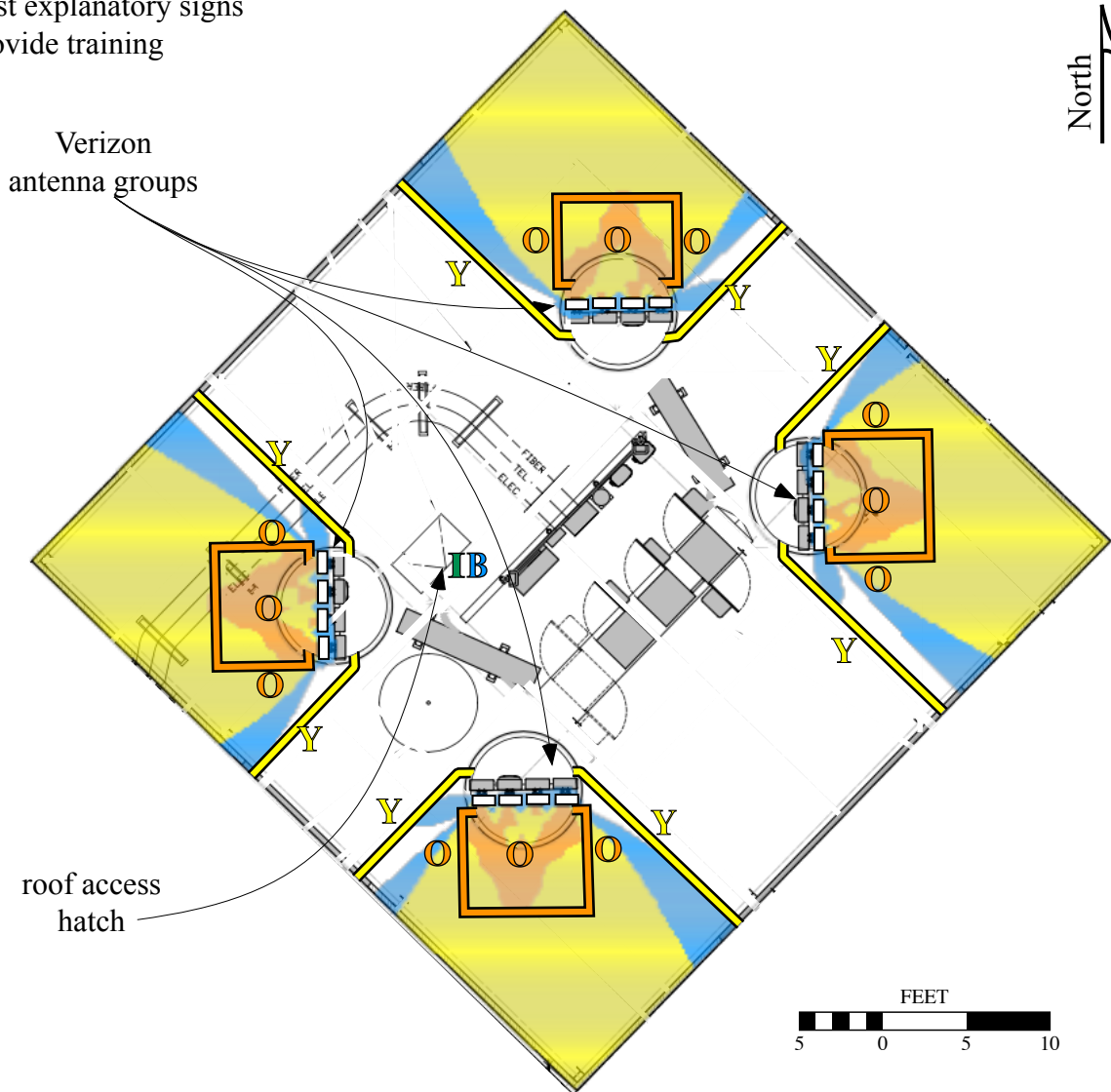
The factor of 2.56 accounts for the increase in power density due to ground reflection, assuming a reflection coefficient of 1.6 (1.6 x 1.6 = 2.56). The factor of 1.64 is the gain of a half-wave dipole relative to an isotropic radiator. The factor of 100 in the numerator converts to the desired units of power density. This formula is used in a computer program capable of calculating, at thousands of locations on an arbitrary grid, the total expected power density from any number of individual radio frequency sources. The program also allows for the inclusion of uneven terrain in the vicinity, as well as any number of nearby buildings of varying heights, to obtain more accurate projections.

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**Calculated RF Exposure Levels on Roof**

**Recommended Mitigation Measures**

- Lock roof access hatch
- Mark boundaries as shown
- Post explanatory signs
- Provide training



Notes: See text.  
 Base drawing from MST Architects, Inc., dated September 18, 2020.  
 Calculations performed according to OET Bulletin 65, August 1997.

<b>Legend:</b>	Less Than Public	Exceeds Public	Exceeds Occupational	Exceeds 10x Occupational
Shaded color	blank	<span style="color: blue;">■</span>	<span style="color: yellow;">■</span>	<span style="color: orange;">■</span>
Boundary marking	N/A	<span style="color: blue;">—</span>	<span style="color: yellow;">—</span>	<span style="color: orange;">—</span>
Sign type	<b>I</b> - Green INFORMATION	<b>B</b> - Blue NOTICE	<b>Y</b> - Yellow CAUTION	<b>O</b> - Orange WARNING