Evaluation of the Radiofrequency Environment in the Vicinity of the Proposed

WEC-ME-02

Wireless Facility

0 Factory Pasture Road,

Kennebunk, ME 04043

Located in the County of York

Prepared for

Wireless EDGE Towers III, LLC

by

PierCon Solutions, LLC
April 25, 2025

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1.0 SUMMARY AND COMPLIANCE STATUS

Wireless EDGE Towers III, LLC, proposes to construct and operate a new wireless communications installation located at **0 Factory Pasture Road, Kennebunk, ME 04043.** The wireless communications facility will be a 176' monopole with space to support multiple carriers at a variety of heights.

PierCon Solutions LLC, an engineering firm specializing in wireless communications, was contracted to perform an independent assessment of this facility and its environs on behalf of Wireless EDGE Towers III, LLC. The primary purpose of this assessment is to predict whether the radio frequency ("RF") environment at the wireless communications site location and in its immediate surroundings will be in compliance with guidelines for applicable limits for human exposure to radiofrequency fields, as adopted by the Federal Communications Commission ("FCC"). To perform this assessment, PierCon Solutions personnel obtained applicable engineering data, drawings from the applicant and obtained antenna specifications from the manufacturer.

RF information was collected and analyzed using methodology recommended by the Federal Communication Commission's Office of Engineering and Technology in Bulletin 65 *Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields,* 97-01 (OET Bulletin 65) and of Richard Tell in his *CTIA's EME Design and Operation Considerations for Wireless Antenna Sites November 15, 1996*.

The completed assessment includes consideration of contributions to the radiofrequency environment from the obtained construction drawings for the site. Used in this analysis of the proposed telecommunications facility were carrier installation for AT&T, Verizon Wireless, T-Mobile, and Dish Network at antenna centerlines of 170', 160', 150' and 140' respectively. The analysis was performed using typical design criteria for AT&T, Verizon Wireless, T-Mobile, and Dish Network with the assumption of the following frequency bands and technology deployed: LTE service in the 700 MHz, 850 MHz, 1900 MHz, 2100 MHz, and 2500 MHz frequency bands; and 5G service in the 600MHz, 700MHz, 850MHz, 1900MHz, 2100MHz, 2500 MHz, and 3700MHz frequency bands.

PierCon Solutions predicted the future radiofrequency environment by adding the worst-case RF contribution, in terms of percentage of applicable FCC limits, from the proposed and existing installations. The FCC's general public exposure limits were applied which are the strictest criteria.

After reviewing and analyzing the information gathered and considering relevant factors, PierCon Solutions, LLC has made the following determination regarding the site's compliance with applicable guidelines for Maximum Permissible Exposure (MPE) limits, as defined by the FCC. The potential RF exposures will be well below general public limits for all publicly accessible areas in this location and nearby properties.

This site will be in compliance with applicable FCC radiofrequency exposure limits.

2.0 PREDICTIVE ANALYSIS

2.1 Technical data used in this predictive analysis

Technical input parameters used or considered in the predictive modeling performed in this study are identified in the following tables.

AT&T Wireless Radio Parameters					
Service Type	LTE 2100 MHz	LTE 850 MHz	LTE 1900 MHz	LTE 700 MHz	3700 MHz
Transmission Frequency Band	2100 MHz Band	850 MHz Band	1900 MHz Band	700 MHz Band	3700 MHz Band
Antenna Height above ground level (centerline)	170 feet AGL	170 feet AGL	170 feet AGL	170 feet AGL	170 feet AGL
Person Height above ground level	6 feet AGL	6 feet AGL	6 feet AGL	6 feet AGL	6 feet AGL
Antenna type	Panel	Panel	Panel	Panel	Panel
Antenna Manufacturer	COMMSCOPE	COMMSCOPE	COMMSCOPE	COMMSCOPE	NOKIA
Antenna Model	COMMSCOPE NNHH-65C-R4_Port 6 -45_02DT_2130	COMMSCOPE NNHH-65C-R4_Port 1 +45_04DT_0851	COMMSCOPE NNHH-65C-R4_Port 5 +45_02DT_1990	COMMSCOPE NNHH-65C-R4_Port 1 +45_04DT_0710	Nokia_AEQK_3700_10dt
Antenna Length	96 inches	96 inches	96 inches	96 inches	48 inches

Table 1 – AT&T Radio Parameters

Verizon Wireless Radio Parameters							
Service Type	5G LSUB6	LTE 1900	LTE 700	LTE 2100	CBRS 3.7 GHZ	LTE 850	5G NR 850 MHz
Transmission Frequency Band	3700 MHz Band	1900 MHz Band	700 MHz Band	2100 MHz Band	3700 MHz Band	850 MHz Band	850 MHz Band
Antenna Height above ground level (centerline)	160 feet AGL	160 feet AGL	160 feet AGL	160 feet AGL	160 feet AGL	160 feet AGL	160 feet AGL
Person Height above ground level	6 feet AGL	6 feet AGL	6 feet AGL	6 feet AGL	6 feet AGL	6 feet AGL	6 feet AGL
Antenna type	Panel	Panel	Panel	Panel	Panel	Panel	Panel
Antenna Manufacturer	Ericsson	COMMSCOPE	COMMSCOPE	COMMSCOPE	NOKIA	COMMSCOPE	RFS
Antenna Model	Ericsson Air6449NR	COMMSCOPE NHH-65C-R2B_Port 3 +45_02DT_1900	COMMSCOPE NHH-65C-R2B_Port 1 +45_02DT_0704	COMMSCOPE NHH-65C-R2B_Port 3 +45_02DT_2100	Nokia_AEQK_3700_10dt	COMMSCOPE NHH-65C-R2B_Port 1 +45_02DT_0850	RFS APXVAALL24_43-U-NA20-1-2-835+
Antenna Length	39 inches	96 inches	96 inches	96 inches	48 inches	96 inches	96 inches

Table 2 – Verizon Radio Parameters

T-Mobile Radio Parameters							
Service Type	5G NR	LTE	5G NR	LTE	5G NR	LTE	5G NR
Transmission Frequency Band	T-MOBILE 5G NR 600 MHz	T-Mobile LTE 700 MHz	T-MOBILE 5G NR 2500 MHz	T-Mobile LTE 2100 MHz	T-MOBILE 5G NR 1900 MHz	T-Mobile LTE 1900 MHz	T-Mobile 5G NR 2100 MHz
Antenna Height above ground level (centerline)	150 feet AGL	150 feet AGL	150 feet AGL	150 feet AGL	150 feet AGL	150 feet AGL	150 feet AGL
Person Height above ground level	6 feet AGL	6 feet AGL	6 feet AGL	6 feet AGL	6 feet AGL	6 feet AGL	6 feet AGL
Antenna type	Panel	Panel	Panel	Panel	Panel	Panel	Panel
Antenna Manufacturer	RFS	RFS	Ericsson	RFS	RFS	RFS	RFS
Antenna Model	RFS APXVAARR 18_43-U-NA20-1-9-617+	RFS APXVAARR 18_43-U-NA20-1-9-707+	Ericsson Air6419NR	RFS APXVAARR 18_43-U-NA20-5-2-2110+	RFS APXVAARR 18_43-U-NA20-5-2-1910+	RFS APXVAARR 18_43-U-NA20-5-2-1910+	RFS APXVAARR 18_43-U-NA20-5-2-2110+
Antenna Length	72 inches	72 inches	39 inches	72 inches	72 inches	72 inches	72 inches

Table 3 – T-Mobile Radio Parameters

Dish Radio Parameters				
Service Type	5G NR 600MHz	5G NR 700MHz	5G NR 1900MHz	5G NR 2100MHz
Transmission Frequency Band	600 MHz Band	700 MHz Band	1900 MHz Band	2100 MHz Band
Antenna Height above ground level (centerline)	140 feet AGL	140 feet AGL	140 feet AGL	140 feet AGL
Person Height above ground level	6 feet AGL	6 feet AGL	6 feet AGL	6 feet AGL
Antenna type	Directional Panel	Directional Panel	Directional Panel	Directional Panel
Antenna Manufacturer	JMA	JMA	JMA	JMA
Antenna Model	JMA Wireless MX08FRO665-21_Port1_+45_02.5DT_0622_V6P	JMA Wireless MX08FRO665-21_Port1_+45_02.5DT_0750_V6P	JMA Wireless MX08FRO665-21_Port1_+45_02.5DT_2007_V6P	JMA Wireless MX08FRO665-21_Port1_+45_02.5DT_2190_V6P
Antenna Length	72 inches	72 inches	72 inches	72 inches

Table 4 – Dish Radio Parameters

2.2 FCC AND STATE GUIDELINES

The FCC has established two sets of Maximum Permissible Exposure (MPE) limits. Occupational/controlled limits apply to RF exposures to workers who are in an area as a consequence of their occupations, as long as they have been made fully aware of their potential for exposure to RF fields and are able to exercise control over their exposure.

For everyone else, general population/uncontrolled limits apply. These limits are extremely protective, in consideration of the most vulnerable members of the public. For sites where the surrounding area is generally accessible by members of the general population, the FCC general population/uncontrolled MPE limits are generally applied.

The analysis in this report uses the FCC General Public standards (the strictest).

2.3 MPE ANALYSIS FROM HORIZONTAL AND VERTICAL PERSPECTIVE

The Power Density Calculations in the analysis must take into account the distance between the location of the general public versus the location of the transmitting antennas (from both a horizontal and vertical perspective). From a horizontal perspective, the standard Power Density Calculations are performed from 0 to 2000 feet from the wireless communication site (in 5 foot increments).

From a vertical perspective, a factor must be included in order to account for differences between the general public's height above ground level versus the wireless communication site's ground elevation. These differences are typically caused by fluctuations in local ground elevation or multi-story buildings with outdoor areas where the general public may occupy. An analysis was performed to determine the appropriate height factor for the general public to include in the worst-case power density calculation. The height factor is 6' for the general public which represents a 6' tall person standing in the nearby area. Separate analyses were performed at different height factors based on an evaluation of the changing terrain in the surrounding area. The analyses where the predicted MPE exceeds that calculated with the 6' height factor in the relevant range are as follows:

- A height factor of 18' to represent a 6' tall person standing at a nearby school where the ground level is 12' higher than the base of the proposed installation.
- A height factor of 46' to represent a 6' tall person standing in a nearby suburb where the ground level is 40' higher than the base of the proposed installations.

3.0 RESULTS OF THE ANALYSIS

The analysis was performed using the technical input parameters shown in Section 2.1 in order to calculate the wireless communications site's worst-case % MPE from the proposed transmitters.

Figure 1 shows a graph of the wireless communication site's % MPE versus its distance from the general public (within the first 2000 feet) at 6' above ground. For each location, the % MPE is calculated by summing each Service Type by the existing and proposed providers' % MPE values.

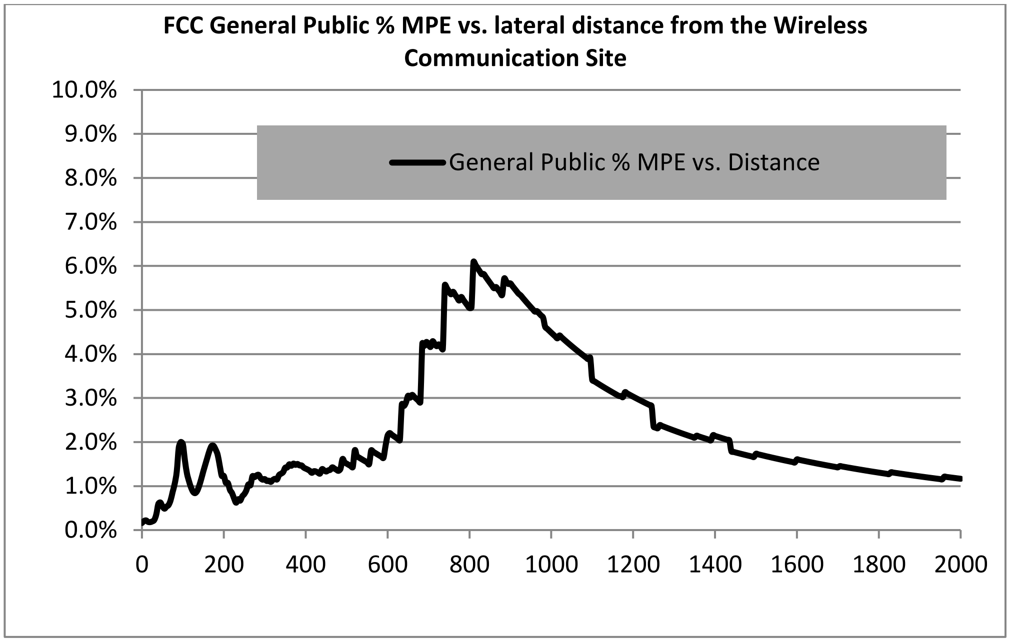

Figure 1 – FCC General Public % MPE vs lateral distance from the Wireless Communications Site from the proposed Transmitters at grade level.

The worst-case combined general public RF exposures to transmissions from the existing wireless facility at 6 feet above ground level is:

- **6.09%** of (or 16.41 times below) the **FCC Maximum Permissible Exposure** limit for General Public. This maximum value was calculated to occur at a distance of **810 feet** from the wireless facility.

Figure 2 shows a graph of the wireless communication site's % MPE versus its distance from the general public (within the first 2000 feet) at 18' above ground. For each location, the % MPE is calculated by summing each Service Type by the existing and proposed providers' % MPE values

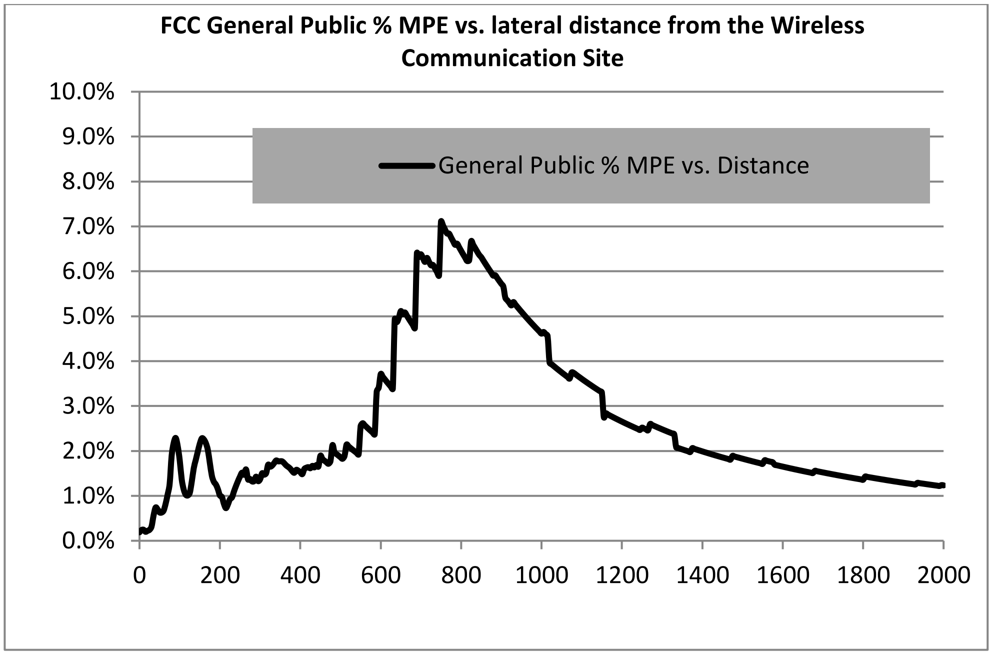

Figure 2 – FCC General Public % MPE vs lateral distance from the Wireless Communications Site from the proposed Transmitters at 18' above ground level.

The worst-case combined general public RF exposures to transmissions from the existing wireless facility at 18 feet above ground level is:

- **7.11%** of (or 14.07 times below) the **FCC Maximum Permissible Exposure** limit for General Public. This maximum value was calculated to occur at a distance of **750 feet** from the wireless facility.

Figure 3 shows a graph of the wireless communication site's % MPE versus its distance from the general public (within the first 2000 feet) at 46' above ground. For each location, the % MPE is calculated by summing each Service Type by the existing and proposed providers' % MPE values.

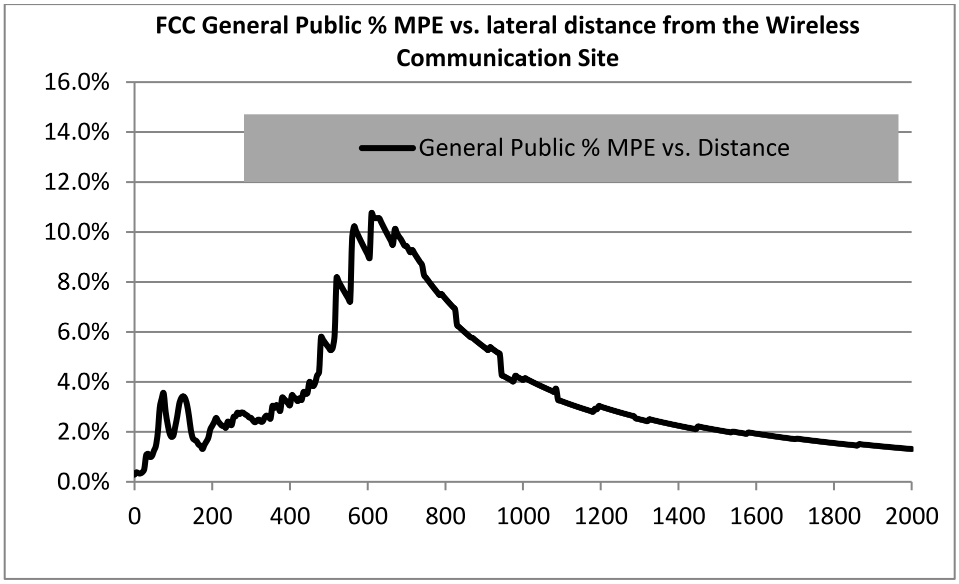

Figure 3 – FCC General Public % MPE vs lateral distance from the Wireless Communications Site from the proposed Transmitters at 46' above ground level.

The worst-case combined general public RF exposures to transmissions from the existing wireless facility at 46 feet above ground level is:

- **10.75%** of (or 9.30 times below) the **FCC Maximum Permissible Exposure** limit for General Public. This maximum value was calculated to occur at a distance of **610 feet** from the wireless facility.

PierCon Solutions L.L.C.
Specialists in Wireless Systems

4.0 CONCLUSION

This conclusion represents the analysis and compliance assessment by PierCon Solutions, LLC of the predicted RF environment surrounding the wireless communications facility located at 0 Factory Pasture Road, Kennebunk, ME 04043.

The assessment is based on typical collocation installations from wireless carriers T-Mobile, Verizon Wireless, Dish Network and AT&T.

Using conservative predictive calculations, PierCon has considered the effect on the RF environment which will result from operation of the new installation and compared this total combined effect to the applicable limits set by the FCC.

Simultaneous operation, at maximum power, of the wireless communications facility near this location will result in total exposure levels below the Maximum Permissible Exposure limit set by the FCC for public areas. The maximum worst-case combined potential RF exposures will be at least 9.3 times below the applicable limit (10.75% of the FCC limit). This is based upon the calculation for an individual that would be standing on the ground in the nearby suburb at a lateral distance of 610 feet from the site. Total combined RF exposures from all the transmitters sources on this wireless communication site will be substantially lower when standing inside buildings with obstructions between the individual and the transmitters.

PierCon Solutions LLC has determined that all publicly accessible areas in this location and nearby properties will remain in full compliance with all applicable FCC radiofrequency exposure limits, as well as all applicable ANSI, IEEE, and NCRP limits.

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5.0 MATHEMATICAL PREDICTIVE ANALYSIS – METHODS, ASSUMPTIONS USED

5.1 PREDICTIVE METHODS AND ASSUMPTIONS

When using mathematical methods to predict RF energy fields from wireless communications sources, PierCon Solutions follows the methodology recommended in Section 2 of the FCC's Office of Engineering and Technology's Bulletin 65, *Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields,* 97-01 (OET Bulletin 65). In the case of certain near-field exposures, PierCon Solutions also uses modifying methods described in Richard Tell's 1966 publication, *EME Design and Operation Considerations for Wireless Antenna Sites,* a technical report prepared for the Cellular Telecommunications Industry Association, Washington, D.C.

Occasionally, some site specific radio parameters and antenna information are not available. In these cases, the situation is noted and more general information is substituted, based on experience and knowledge of similar operations.

In OET Bulletin 65, a number of formulas are recommended for calculating power density emission levels. The first step in selecting the most appropriate equations to use is to determine whether areas of interest are in the "near-field" or "far-field" regions. Once this determination is made, the appropriate formula is applied.

Areas of interest at this site are found both in the far field and near-field regions of the antennas.

Far-field calculations: The preferred method described in OET Bulletin 65 for predictive far-field calculations assumes perfect (100%) reflection of incoming signal. This factor, resulting in a four-fold increase in predicted power density, was used in this study, to ensure that the conclusions of this report represent a worst-case. Additionally, PierCon uses the following additional highly conservative assumptions:

- Transmitters are assumed to operate continuously and at maximum power, although they customarily operate intermittently and at varying power levels.
- When the RF signal is sent through a coaxial cable from the transmitters to the antennas, significant power losses are expected. Typically, about half the nominal transmitter power (3 dB) is lost. PierCon assumes that there are no power losses.
- Whenever PierCon is aware that a carrier is using more than one antenna model at a given frequency, we perform a worst-case calculation for each model, and then choose the parameters representing the "worst-case" antenna – the one capable of producing the highest predicted RF fields in the areas of interest.
- PierCon assumes that all power available for transmission from all the antennas any one sector is directed through the worst-case antenna mounted closest to ground level. This antenna is assumed to be mounted on the edge of the structure and directly above the point from which the RF field strengths are calculated. Thus, the calculations assume the shortest potential distance between the center of the strongest beams from the antenna and a hypothetical person standing at the level of interest.
- The FCC's MPE exposure limits are defined in terms of "spatial exposure" – the average of a series of partial exposures, head-to-toe, of a six-foot tall human standing in the described field. These partial exposures to RF fields vary in intensity from the person's foot level to head level. The energy fields closer to the ground are further from the antennas and are almost always less intense. In PierCon's far-field calculations, the field strength at head height is assumed to be the average exposure of the person. PierCon's predicted exposure values will always be greater than the actual measured exposure.

In the far-field, the following formula [formula (6) on page 19 of OET Bulletin 65] incorporates a 100% reflection factor is used for calculating power density levels:

Far field: $S_{ff} = EIRP / \pi R^2$

Where: S_{ff} = far-field power density in mW/cm²
EIRP = effective isotropic radiated power (factoring "G" the gain in direction of interest)
R = distance to the center of the antenna, in appropriate units

PierCon applies this equation incrementally, at five-foot intervals, for distances horizontally from the base of the structure to as far as 2,000 feet from the antenna. The RF fields vary directly as a function of gain and inversely as the square of the distance from the center of the antenna. Additional variations are caused by vertical intensity patterns inherent in the design of the various antennas. These variations are taken into account as described on page 22-23 of OET Bulletin 65.

Gain is affected by antenna design. Directional panel antennas (those commonly used by wireless carriers) are designed to focus the majority of emitted energy into a relatively narrow beam, transmitted from the front, center of the antenna. This main beam is typically directed almost horizontally towards the horizon or just below. Relatively little emitted energy is emitted below or above the main beam. Almost no energy escapes behind the antenna. PierCon Solutions incorporates the most specific information available regarding the RF pattern of the antennas being modeled.

Down-tilt (mechanical or electrical) also affects the vertical RF pattern. Greater downtilt typically causes higher intensity portions of the antenna beams to illuminate far field locations at distances closer to the antenna and causes RF fields to be higher. Mechanical down-tilt is set physically, on location. Electrical down-tilt is a design parameter of the antennas. Electrical down-tilt of some modern sector antennas is designed to be variable, either on site or remotely. Typical down-tilts are 0-2 degrees below horizontal. Antennas on tall structures or at high relative elevations may be set with more down-tilt.

When multiple wireless services or providers are on a structure, each service's antennas will produce exposure maxima at different distances from the structure and oriented in different directions. Each carrier's maximum usage load is likely to occur at different times. However, in this situation, PierCon again presents conservative results. Our model assumes that antennas representing each carrier and service at the site all point in the same direction, that all the RF maxima occur at the same distance from the antenna and they are all running at full power, with no power losses. Thus, the combined theoretical maximum RF field strengths which we report will always be more intense than those we would obtain via actual measurements at the site.

Near-field calculations: For modeling near-field situations, the following formula [formula (20) on page 32 of OET Bulletin 65], which models the field as a portion of a cylindrical surface, was developed by Richard Tell and modified by him in a publication referenced in OET Bulletin 65 to include a mounting factor, M.

Near Field: $S_{nf} = (360/\theta_{bw})\ MPnet/2\pi Rh$

Where: S_{nf} = near field power density
P_{net} = net power input to the antenna
θ_{bw} = beam width[1] of the antenna, in degrees
R = distance from the antenna
M = Mounting factor
H = height of the antenna

[1] Azimuth (horizontal) beam width at half-power (3 dB)

Mounting factors, which were also developed by Richard Tell, are explained in his study *EME design and Operation Considerations for Wireless Antenna Sites*[2]. This document is referenced in OET 65, although mounting factors are not included in the simplified equation included in the OET 65 guidelines. This document is also referenced on page 31 of OET 65.

Mounting factors are used to account for the mitigating effect of antenna mounting distance above a roof or similar surface on the RF environment experienced by personnel on the described surface. These mounting factors conservatively emulate spatially averaged exposures of a six-foot-tall person standing as much as ten feet below the bottom of an antenna and on a perfectly reflective surface. When predicting similar exposures due to RF emissions in the near-field from antennas mounted higher than ten feet above the surface of interest, PierCon Solutions uses the ten-foot mounting factor.

6.0 FEDERAL LAWS, FCC RULES AND GUIDELINES

6.1 FEDERAL LAWS

The National Environmental Policy Act of 1969 (NEPA)[3] is a federal law directed at federal agencies. It requires the agencies (including the Federal Communications Commission) to evaluate the effects of their actions on the quality of the human environment. To meet these responsibilities, the FCC adopted a number of requirements to evaluate and limit the environmental impact of its actions.

One of these environmental factors addressed by the FCC is human exposure to RF energy emitted by FCC-regulated transmitters and facilities.[4] The FCC decided that, whenever they must approve construction or operation of a facility, they will require the applicant to determine whether there is a potential impact due to the facility. If applicants are able to attest that the operation meets FCC RF exposure guidelines, the operation is considered not to have an adverse effect on the human environment and is more likely to be approved by FCC.

The Telecommunications Act of 1996[5] (a major revision of the Telecommunications act of 1932) is the applicable federal law regarding controls of the effects of RF emissions from wireless communications facilities on the human environment. With respect to controls on the environmental effects of radiofrequency emissions, the Act states the following:

> *Section 704(a) (7) (B) (i) (II) (iv):*
>
> *"No State or local government or instrumentality thereof may regulate the placement, construction, and modification of personal wireless service facilities on the basis of the environmental effects of radio frequency emissions to the extent that such facilities comply with the Commission's regulations concerning such emissions."*

[2] Tell, Richard A. (1996) *EME Design and Operation Considerations for Wireless Antenna Sites*. Technical report prepared for the Cellular Telecommunications Industry Association, Washington, D.C. 20036.

[3] National Environmental Policy Act of 1969, as amended, 42 U.S.C. §§ 4321 *et seq.* (1976)

[4] This limits FCC responsibilities to effects from manufactured sources and to the range of non-ionizing electromagnetic frequencies which are useful for wireless communications.

[5] Telecommunications Act of 1996, Pub. L. No. 104-104, 110 Stat 56 (1996)

> *Section 704(b): RADIO FREQUENCY EMISSIONS- Within 180 days after the enactment of this Act, the Commission shall complete action in ET Docket 93-62 to prescribe and make effective rules regarding the environmental effects of radio frequency emissions.*

6.2 FCC RULES AND GUIDELINES

In 1985, pursuant to the National Environmental Policy Act of 1969 (NEPA)[6], the FCC established guidelines for human exposure to Radio Frequency (RF) energy emitted by FCC-regulated transmitters. The latest revision of these guidelines fulfilled the requirements of Section 704(b) of the Telecommunications Act of 1996.

The FCC requires their licensees intending to construct or operate wireless communications facilities to ensure that the proposed facilities are designed and maintained to keep human exposures to RF energy produced by the wireless communications facilities within very conservative limits. These limits are intended to protect humans from harm due to known hazards of RF energy.

The FCC guidelines are intended to limit the amount of RF energy to which humans may be exposed due to emissions from FCC–regulated transmitters and facilities. Electromagnetic energy from natural sources (for example, from the Sun or lightning) is beyond the scope of the FCC's mandate, as is electromagnetic energy at higher or lower frequencies than are used for wireless communications (For instance, FCC does not have authority with respect to power-line electromagnetic fields.)

The FCC consistently explains that they are not experts in the field of RF health and safety. In setting limits and recommending methods for evaluating the environmental effects of RF fields, FCC relies on recommendations and advice of federal agencies and other organizations with expertise in evaluating health-related issues and in standards-setting. Such sources include the Environmental Protection Agency (EPA), Occupational Safety and Health Administration (OSHA), National Council on Radiation Protection and Measurements (NRCP), the Institute of Electrical and Electronics Engineers (IEEE), the American National Standards Institute (ANSI).

The FCC lists certain situations in which there is little expectation of non-compliance with RF exposure levels. For these listed situations, FCC does not require routine evaluations. However, compliance with the limits described in their guidelines is always required.

In meeting the requirements of the Telecommunications Act of 1996, FCC adopted and released their current RF exposure guidelines on August 1, 1996 FCC 96-326 "Guidelines for Evaluating the Environmental Effects of Radiofrequency Radiation (ET Docket No. 93-62). The guidelines are incorporated into FCC regulations and codified at 47 CFR 1.1307 and 1.310. These guidelines specify two sets of maximum permissible exposure levels – one for general population/uncontrolled exposures – the other for occupational/controlled situations - indicate criteria for deciding which limits are applicable.

When considering these guidelines, it is important to remember that they:

- Describe exposure limits, not emission limits.
- Apply only in reasonably accessible locations.
- Apply to power densities or the squares of the electric and magnetic field strengths that are spatially averaged over the body dimensions. "Spatially averaged RF fields most accurately relate to estimating the whole body averaged SAR [*Specific Absorption Rate*] that will result from the exposure."

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[6] 42 U.S.C. §§ 4321 et seq. (1976)

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

Limits set by FCC for general population/uncontrolled (or "uncontrolled") situations are applicable to:

- Everyone whose exposure is not a consequence of their employment and
- Everyone who is not made fully aware of the potential for RF exposure and
- Anyone not able to exercise control over their exposure.

FCC permits workers in occupational/controlled situations to be exposed to areas where higher levels of RF energy are present as long as the following criteria are satisfied:

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

For occupational/controlled limits to apply, controlling access to the area is a necessary component, but not sufficient. These limits only apply to people whose exposure is as a consequence of their employment.

- If the area has a potential to expose people at above the limits set for general population/uncontrolled situations, it must be accessible only to those who will be exposed as a consequence of their employment.
- Workers must have been made fully aware of the potential for RF exposure and
- Workers must be able to exercise control over their exposure.

Please refer to the newly published IEEE standard, C95.7-2005 IEEE Recommended Practice for Radio Frequency Safety Programs, 3 kHz to 300 GHz, for recommendations about signage and setting up a safety program and providing training to cover workers and areas at the site where the potential RF environment can be above the FCC limits for general population/ uncontrolled areas. This is the standard prospectively referenced by FCC:

For purposes of developing training programs for employees, we [FCC] note that several resources are becoming available to provide guidance on appropriate RF safety programs. These resources include services provide by commercial vendors as well as information available through governmental and other Internet Web sites. Furthermore a committee of the IEEE, Subcommittee 2 of Standards Coordination Committee 28, is now in the process of drafting an IEEE recommended practice for the development of an RF safety program.[7]

… awareness of the potential for RF exposure in a workplace or similar environment can be provided through specific training as part of an RF safety program. Warning signs and labels can also be used to establish such awareness, as long as they provide information, in a prominent manner, on risk of potential exposure and instructions on methods to minimize such exposure risk.[8]

To make it easier for our licensees and grantees to interpret their responsibilities, we propose to explain in a note to Section 1.310 of our rules that "fully aware" means that an exposed individual has received written and verbal information concerning the potential for RF exposure and has received training regarding appropriate work practices relating to controlling or mitigating his or her exposure.[9]

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[7] FCC Notice of Proposed Rulemaking ET Docket 03-137, FCC 03-132, adopted June 12, 2003, – footnote to paragraph 38.

[8] See OET Bulletin 65, p10. Also see FCC Report and Order, ET Docket 93-62, FCC 96-326, adopted August 1996, paragraph 45.

[9] FCC Notice of Proposed Rulemaking ET Docket 03-137, FCC 03-132, adopted June 12, 2003, paragraph 38.

Incidental or "transient" workers: FCC recognizes that the exposure of many workers to RF energy from communications transmission equipment is incidental to their employment. For example, per OET 65, p55: "*Persons who are only 'transient' visitors to the rooftop, such as air conditioning technicians, etc. could also be considered to fall within the occupational/controlled criteria as long as they are also 'made aware' of their exposure and exercise control over their exposure.*"

FCC recognizes that these individuals do not require in depth training regarding RF exposures. They state: "*As specified in the rules, transient individuals must simply be made aware of their exposure. This could be achieved by means of written and/or verbal information, including, for instance, appropriate signage.*"[10]

At this site, appropriate signage should be posted to establish occupational "awareness" of the potential for RF exposure and remind workers of procedures available to them to exercise control over their exposure.

> ***F.37****. the occupational/controlled limits in our [FCC] rules apply "in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure."*

Limits for occupational/controlled exposure also apply *"in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure."*[11] Posting awareness signage is particularly useful to satisfy the FCC[12] intentions to ensure the awareness of "transient" workers – those who may come near a transmitting antenna in the course of other duties.

General population/uncontrolled exposure limits apply *"in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or cannot exercise control over their exposure.*[13]

6.3 BACKGROUND ON FCC RF EXPOSURE LIMITS (GUIDELINES)

In 1985, the FCC first adopted guidelines to be used for evaluating human exposure to RF emissions.[14] The FCC revised and updated these guidelines on August 1, 1996, as a result of a rule-making proceeding initiated in 1993[15] and to satisfy the requirements of Section 704 (b) of the Telecommunications Act of 1996. Because its licensees must meet the FCC's guidelines or answer to the FCC, these guidelines effectively set the current exposure limits for FCC licensees.

These guidelines incorporate two tiers of exposure limits and two sets of time-averaging provisions, based on whether the RF exposures occur to informed workers in an occupational/controlled situation or to members of general public, in an "uncontrolled" situation. The guidelines incorporate limits for Maximum Permissible Exposure (MPE) in terms of electric and magnetic field strength and power density for transmitters operating at frequencies between 300 kHz (0.3 MHz) and 100 GHz (100,000 MHz). The guidelines are based on exposure

[10] Ibid: paragraph 38.

[11] 47 CFR § 1.1310 Table 1, Note 1.

[12] FCC ET Docket No. 03-137 NPRM, released June 26, 2003

[13] 47 CFR § 1.1310 Table 1 Note 2.

[14] *Report and Order,* GEN Docket No. 79-144, 100 FCC 2d 543 (1985); and *Memorandum Opinion and Order,* 58 RR 2d 1128 (1985). The guidelines originally adopted by the FCC were the 1982 RF protection guides issued by the American National Standards Institute (ANSI).

[15] *Report and Order*, ET Docket 93-62, FCC 96-326, adopted August 1, 1996, 61 Federal Register 41,006 (1996), 11 FCC Record 15,123 (1997). The FCC initiated this rule-making proceeding in 1993 in response to the 1992 revision by ANSI of its earlier guidelines for human exposure. The Commission responded to seventeen petitions for reconsideration filed in this docket in two separate Orders: *First Memorandum Opinion and Order,* FCC 96-487, adopted December 23, 1996, 62 Federal Register 3232 (1997), 11 FCC Record 17,512 (1997); and *Second Memorandum Opinion and Order and Notice of Proposed Rulemaking,* FCC 97-303, adopted August 25, 1997.

limits recommended by the NCRP[16] in 1986 and, over a wide range of frequencies, on exposure limits developed by IEEE and adopted by the American National Standards Institute (ANSI) to replace the 1982 ANSI guidelines.[17]

The FCC states that, in reaching its decision on adopting these guidelines, it carefully considered the large number of comments submitted during its rule-making proceeding and gave particular weight to comments submitted by the EPA, FDA and other federal health and safety agencies. The current guidelines are based substantially on the recommendations of those agencies. The FCC states that it believes the guidelines represent a consensus view of the federal agencies responsible for matters relating to public safety and health.

The basis (reference level) of the FCC's RF exposure limits, and the NCRP and ANSI/IEEE limits upon which the FCC limits are scientifically based is a whole-body averaged Specific Absorption Rate (SAR)[18] threshold level of 4 watts per kilogram (4 W/kg), as averaged over the entire mass of the body. Expert organizations have determined that adverse biological effects may occur above this SAR.

FCC exposure limits are also frequency dependent, in response to data showing that the human body absorbs RF energy at some frequencies more efficiently than at others. As listed OET 65, Table 1 of Appendix A and 47 CFR 1.1310 Table 1, the most restrictive limits occur in the frequency range of 30-300 MHz where whole-body absorption of RF energy by human beings is most efficient. At other frequencies whole-body absorption is less efficient and the corresponding MPE limits are less restrictive.

Current MPE limits are derived by incorporating safety factors that lead, in some cases, to limits that are more conservative than the limits originally adopted by the FCC in 1985. Where more conservative limits exist they do not arise from a fundamental change in the RF safety criteria for whole-body averaged SAR, but from a precautionary desire to protect subgroups of the general population who, potentially, may be more at risk. The object of the various limits, including those in the FCC rules, is to limit SAR due to occupational/controlled exposures to 0.4W/kg or less (time averaged over any six minute period). This incorporates a safety factor of 10. Regarding exposures to the general public and anyone who may not be aware of the potential for RF exposure, the limit is set at 0.08 W/kg (time averaged over any 30 minute period. This incorporates a safety factor of 50.

The FCC makes it clear that the MPE limits are exposure limits, not emission limits and therefore apply only in accessible areas. Fundamentally, in areas that are considered normally inaccessible, the exposure limits do not apply.

7.0 TABLE OF FCC RF EXPOSURE LIMITS (47 CFR 1.1310 TABLE 1)

Table 1. LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

(A) Limits for Occupational/Controlled Exposure

Frequency	Electric Field	Magnetic Field	Power Density	Averaging Time

[16] "Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields," NCRP Report No. 86 (1986), National Council on Radiation Protection and Measurements (NCRP), Bethesda, MD. The NCRP is a non-profit corporation chartered by the U.S. Congress to develop information and recommendations concerning radiation protection.

[17] ANSI/IEEE C95.1-1992, "Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz." Copyright 1992, The Institute of Electrical and Electronics Engineers, Inc., New York, NY. The 1992 ANSI/IEEE exposure guidelines for field strength and power density are similar to those of NCRP Report No. 86 for most frequencies except those above 1.5 GHz.

[18] Specific absorption rate is a measure of the rate of energy absorption by the body. SAR limits are specified for both whole-body exposure and for partial-body or localized exposure (generally specified in terms of spatial peak values).

Range (MHz)	Strength (E) (V/m)	Strength (H) (A/m)	(S) (mW/cm²)	|E|², |H|² or S (minutes)
0.3-3.0	614	1.63	(100)*	6
3.0-30	1842/f	4.89/f	(900/f²)*	6
30-300	61.4	0.163	1.0	6
300-1500	--	--	f/300	6
1500-100,000	--	--	5	6

(B) Limits for General Population/Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm²)	Averaging Time |E|², |H|² or S (minutes)	
0.3-1.34	614	1.63	(100)*	30	
1.34-30	824/f	2.19/f	(180/f²)*	30	30-
300	27.5	0.073	0.2	30	
300-1500	--	--	f/1500	30	
1500-100,000	--	--	1.0	30	

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

NOTE 1: ***Occupational/controlled*** limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2: ***General population/uncontrolled*** exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

8.0 DEFINITIONS AND GLOSSARY OF TERMS (FROM OET BULLETIN 65)

The following is directly from OET Bulletin 65, edition 97-01 and are standard terminology used in studies of human exposure to RF electromagnetic fields, including in this report.

These definitions are adapted from those included in the American National Standards Institute (ANSI) 1992 RF exposure standard [Reference 1], from NCRP Report No. 67 [Reference 19] and from the FCC's Rules (47 CFR § 2.1 and § 1.1310).

Average (temporal) power. The time-averaged rate of energy transfer.

Averaging time. The appropriate time period over which exposure is averaged for purposes of determining compliance with RF exposure limits (discussed in more detail in Section 1 of OET 65).

Continuous exposure. Exposure for durations exceeding the corresponding averaging time.

Decibel (dB). Ten times the logarithm to the base ten of the ratio of two power levels.

Duty factor. The ratio of pulse duration to the pulse period of a periodic pulse train. Also, may be a measure of the temporal transmission characteristic of an intermittently transmitting RF source such as a paging antenna by dividing average transmission duration by the average period for transmissions. A duty factor of 1.0 corresponds to continuous operation.

Effective radiated power (ERP) (in a given direction). The product of the power supplied to the antenna and its gain relative to a half-wave dipole in a given direction.

Equivalent Isotropically Radiated Power (EIRP). The product of the power supplied to the antenna and the antenna gain in a given direction relative to an isotropic antenna.

Electric field strength (E). A field vector quantity that represents the force (**F**) on an infinitesimal unit positive test charge (**q**) at a point divided by that charge. Electric field strength is expressed in units of volts per meter (V/m).

Energy density (electromagnetic field). The electromagnetic energy contained in an infinitesimal volume divided by that volume.

Exposure. Exposure occurs whenever and wherever a person is subjected to electric, magnetic or electromagnetic fields other than those originating from physiological processes in the body and other natural phenomena.

Exposure, partial-body. Partial-body exposure results when RF fields are substantially nonuniform over the body. Fields that are nonuniform over volumes comparable to the human body may occur due to highly directional sources, standing-waves, re-radiating sources or in the near field. See **RF "hot spot".**

Far-field region. That region of the field of an antenna where the angular field distribution is essentially independent of the distance from the antenna. In this region (also called the free space region), the field has a predominantly plane-wave character, i.e., locally uniform distribution of electric field strength and magnetic field strength in planes transverse to the direction of propagation.

Gain (of an antenna). The ratio, usually expressed in decibels, of the power required at the input of a loss-free reference antenna to the power supplied to the input of the given antenna to produce, in a given direction, the same field strength or the same power density at the same distance. When not specified otherwise, the gain refers to the direction of maximum radiation. Gain may be considered for a specified polarization. Gain may be referenced to an isotropic antenna (dBi) or a half-wave dipole (dBd).

General population/uncontrolled exposure. For FCC purposes, applies to human exposure to RF fields when the general public is exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Therefore, members of the general public always fall under this category when exposure is not employment-related.

Hertz (Hz). The unit for expressing frequency, ***(f)***. One hertz equals one cycle per second.

Magnetic field strength (H). A field vector that is equal to the magnetic flux density divided by the permeability of the medium. Magnetic field strength is expressed in units of amperes per meter (A/m).

Maximum permissible exposure (MPE). The rms and peak electric and magnetic field strength, their squares, or the plane-wave equivalent power densities associated with these fields to which a person may be exposed without harmful effect and with an acceptable safety factor.

Near-field region. A region generally in proximity to an antenna or other radiating structure, in which the electric and magnetic fields do not have a substantially plane-wave character, but vary considerably from point to point. The near-field region is further subdivided into the reactive near-field region, which is closest to the radiating structure and that contains most or nearly all of the stored energy, and the radiating near-field region where the radiation field predominates over the reactive field, but lacks substantial plane-wave character and is complicated in structure. For most antennas, the outer boundary of the reactive near field region is commonly taken to exist at a distance of one-half wavelength from the antenna surface.

Occupational/controlled exposure. For FCC purposes, applies to human exposure to RF fields when persons are exposed as a consequence of their employment and in which those persons who are exposed have been made fully aware of the potential for exposure and can exercise control over their exposure. Occupational/controlled exposure limits also apply where exposure is of a transient nature as a result of incidental passage through a location where exposure levels may be above general population/uncontrolled limits (see definition above), as long as the exposed person has been made fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

Peak Envelope Power (PEP). The average power supplied to the antenna transmission line by a radio transmitter during one radiofrequency cycle at the crest of the modulation envelope taken under normal operating conditions.

Power density, average (temporal). The instantaneous power density integrated over a source repetition period.

Power density (S). Power per unit area normal to the direction of propagation, usually expressed in units of watts per square meter (W/m^2) or, for convenience, units such as milliwatts per square centimeter (mW/cm^2) or microwatts per square centimeter ($\mu W/cm^2$). For plane waves, power density, electric field strength (E) and magnetic field strength (H) are related by the impedance of free space, i.e., 377 ohms, as discussed in Section 1 of this bulletin. Although many survey instruments indicate power density units ("far-field equivalent" power density), the actual quantities measured are E or E^2 or H or H^2.

Power density, peak. The maximum instantaneous power density occurring when power is transmitted.

Power density, plane-wave equivalent or far-field equivalent. A commonly-used terms associated with any electromagnetic wave, equal in magnitude to the power density of a plane wave having the same electric (E) or magnetic (H) field strength.

Radiofrequency (RF) spectrum. Although the RF spectrum is formally defined in terms of frequency as extending from 0 to 3000 GHz, for purposes of the FCC's exposure guidelines, the frequency range of interest in 300 kHz to 100 GHz.

Re-radiated field. An electromagnetic field resulting from currents induced in a secondary, predominantly conducting object by electromagnetic waves incident on that object from one or more primary radiating structures or antennas. Re-radiated fields are sometimes called "reflected" or more correctly "scattered fields." The scattering object is sometimes called a "re-radiator" or "secondary radiator".

RF "hot spot." A highly localized area of relatively more intense radio-frequency radiation that manifests itself in two principal ways:

(1) The presence of intense electric or magnetic fields immediately adjacent to conductive objects that are immersed in lower intensity ambient fields (often referred to as re-radiation), and

(2) Localized areas, not necessarily immediately close to conductive objects, in which there exists a concentration of RF fields caused by reflections and/or narrow beams produced by high-gain radiating antennas or other highly directional sources. In both cases, the fields are characterized by very rapid changes in field strength with distance. RF hot spots are normally associated with very nonuniform exposure of the body (partial body exposure). This is not to be confused with an actual thermal hot spot within the absorbing body.

Root-mean-square (rms). The effective value, or the value associated with joule heating, of a periodic electromagnetic wave. The rms value is obtained by taking the square root of the mean of the squared value of a function.

Scattered radiation. An electromagnetic field resulting from currents induced in a secondary, conducting or dielectric object by electromagnetic waves incident on that object from one or more primary sources.

Short-term exposure. Exposure for durations less than the corresponding averaging time.

Specific absorption rate (SAR). A measure of the rate of energy absorbed by (dissipated in) an incremental mass contained in a volume element of dielectric materials such as biological tissues. SAR is usually expressed in terms of watts per kilogram (W/kg) or milliwatts per gram (mW/g). Guidelines for human exposure to RF fields are based on SAR thresholds where adverse biological effects may occur. When the human body is exposed to an RF field, the SAR experienced is proportional to the squared value of the electric field strength induced in the body.

Wavelength (λ). The wavelength (λ) of an electromagnetic wave is related to the frequency (***f***) and velocity (***v***) by the expression $v = f\lambda$. In free space the velocity of an electromagnetic wave is equal to the speed of light, i.e., approximately 3×10^8 m/s.

9.0 REFERENCES

[1] FCC OET Bulletin 65, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields", Edition 97-01, August 1997.

[2] FCC 47 CFR 1.1307 Parts 1, 2, 15, 24 and 97.

[3] FCC OET Bulletin 56, "Questions and Answers about Biological Effects and Potential Hazards of Radiofrequency Electromagnetic Fields", Fourth Edition, August 1999.

[4] FCC 47 CFR 1.1310 "Practice and procedure, Radiofrequency radiation exposure limits"

[5] NARDA "Non-Ionizing Radiation Handbook"

[6] Rutgers University, "Management of Electromagnetic Energy Hazards", October 1993.

[7] Telecommunications Act of 1996

[8] *Report and Order*, ET Docket 93-62, FCC 96-326, adopted August 1, 1996, 61 Federal Register 41,006 (1996), 11 FCC Record 15,123 (1997).

[9] "Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields," NCRP Report No. 86 (1986), National Council on Radiation Protection and Measurements (NCRP), Bethesda, MD.

[10] ANSI/IEEE C95.1-1992, "Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz." Copyright 1992, The Institute of Electrical and Electronics Engineers, Inc., New York, NY.

[11] Tell, R.A., "CTIA's EME design and operations considerations for wireless antenna sites," Technical Report for the Cellular Telecommunications Industry Association, Washington, DC, prepared by Richard A. Tell Associates, Inc., Las Vegas, NY 1996

[12] IEEE C95.3-2002 "Practice for Measurements and Computations of Radio Frequency Electromagnetic Fields with Respect to Human Exposure to Such Fields, 100 kHz-300 GHz" ANSI/IEEE, The Institute of Electrical and Electronic Engineers Inc., (IEEE), New York, NY 10017

[13] IEEE C95.7-2005 "IEEE Recommended Practice for Radio Frequency Safety Programs, 3 kHz to 300 GHz" ANSI/IEEE. The Institute of Electrical and Electronic Engineers Inc., (IEEE), New York, NY 10017

10.0 APPRENDIX