Electromagnetic Radiation Exposure Estimation

A1 Introduction

Fixed Wireless Terminal emit RF radiation (Radiation Hazard). Although there is no scientific evidence of possible health risks to persons living near to fixed wireless terminal, some recommendations are giving below for the installation and operation of fixed wireless terminal transceivers. Operators of fixed wireless terminal transceivers are required to obey the local regulation for erecting mobile station transceivers.

The Federal Communications Commission (FCC), are imposing MPE (maximum permissible exposure) limits. FCC CFR part 1, subpart I, section 1.1307 requires operator to perform a Enviromenta Assemessmet (EA). Equipment listed in the table 1 of before mentioned part are subjected to routine environmental evaulation. For facilities and operations licensed under part 22, licensees and manufactuere are required tto ensure that their facility and equipment comply with IEEE C95.1-1999.

The objective of the Environmental Evaluation is to ensure that human exposure to RF energy does not go beyond the maximum permissible levels stated in the standard. Therefore certain sites do not require an evaluation by nature of its design. It could be that the antennas are placed high enough thereby resulting in extremely low RF fields by the time it reaches areas that would be accessible to people. Environmental evaluations are required, for Pbulic Mobile Services, Part 22: Cellular Radiotelephone Service ,Subpart H;

1) Non-rooftop antennas: height of radiation center < 10m above ground level and total power of all channels > 2000 W ERP (3280 W EIRP)
2) Rooftop antennas: total power of all channels > 2000 W ERP (3280 W EIRP)

A2 Maximum Permissible Exposure (MPE)

Maximum permissible exposure (MPE) refers to the RF energy that is acceptable for human exposure, given the scientific research to date. It is broken down into two categories, Controlled and Uncontrolled. Controlled limits are used for persons such as installers and designers that are in control of the hazard and exposed to energy for limited amounts of time per day. Occupational/controlled limits apply in situations in which are 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.

Uncontrolled limits are used for general public. General population/uncontrolled exposure apply in situations is 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. The exposure levels can be expressed in terms of power density, electric field strength, or magnetic field strength, as averaged over 30 minutes for the general public and 6 minutes for trained personnel. The exposure criterion is frequency dependent, and a chart covering the range from 3 kHz to 100 GHz can be found in NCRP No.86 (references IEEE C95.1-1991). Below are the limits.

Limits for Occupational/Controlled Exposure			
Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm2)
0.3-3.0	614	.63	(100)*
3.0-30	1842/f	4.89/f	(900/f2)*
30-300	61.4	0.163	1.0
300-3000	--	--	f/300
3000-15,000	--	--	5

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)
0.3-3.0	614	1.63	(100)*
3.0-30	842/f	2.19/f	(180/f2)*
30-300	27.5	0.073	0.2
300-3000	--	--	f/1500
3000-15,000	--	--	1.0

For mostly safe in the extreme condition, we take the lowest frequency to calculate:

Power density S [mW/cm^2] for controlled area at 824 MHz

$$S = \frac{f[MHz]}{300} = \frac{824}{300} = 2.75 mW/cm^2$$

Power density S [mW/cm^2] for uncontrolled area at 1930 MHz

$$S = \frac{f[MHz]}{1500} = \frac{824}{1500} = 0.55 mW/cm^2$$

A3 Calculation of the Safe Distance

Calculations can be made on a site by site basis to ensure the power density is below the limits given above, or guidelines can be done beforehand to ensure the minimum distances from the antenna is maintained through the site planning. The calcualtions are based on FCC OET 65 Appendix B.

A4 Prediction of the Exposure to Electromagnetic Fields

Below method describes a theoretical approach to calculate possible exposure to electromagnetic radiation around a mobile station transceiver antenna. Precise statements are basically only possible either with measurements or complex calculations considering the complexity of the environment (e.g. soil conditions, near buildings and other obstacles) which causes reflections, scattering of electromagnetic fields.

The maximum output power (given in ERP) of a mobile station is usually limited by license conditions of the network operator.

A rough estimation of the expected exposure in power flux density on a given point can be made with the following equation. The calcualtions are based on FCC OET 65 Appendix B.

$$S = \frac{Pt(W) * G_{numeric}}{4 * r^2(m) * \pi}$$

Whereas:

Pt = Maximum output power of the transmitter

$G_{numeric}$ = Numeric gain of the antenna relative to isotropic antenna

R = distance between the antenna and the point of exposure in meters

A5 Calculation of the Safe Distance

Calculations can be made on a site by site basis to ensure the power density is below the limits given above, or guidelines can be done beforehand to ensure the minimum distances from the antenna is maintained through the site planning.

$$r = \sqrt{\frac{1.64 * G_d * Pt}{4\pi S}}$$

Whereas:

r = distance from the antenna [m]

G_d = Antenna gain relative to half wave dipole

Pt = Maximum output power of the transmitter

S = power density [W/m^2] see also MPE Limits

Note: $1mW/cm^2 = 10W/m^2$

For the antennas used by Huawei CDMA fixed wireless terminal ETS3228 in the 824MHz~849MHz, there is six type of antenna could be installed for the different network configuration. We take the worst case to calculate, it means that the maximum ERP power will be used. In this configuration for 800MHz US Cellular System, there will be two channels per one sector at the same carrier and the transmitting antenna is beamed.

$$r = \sqrt{\frac{G_{numeric} * Pt}{4\pi S}}$$

It's important to note that reflections from the ground and nearby fences can increase the power density from the mobile station by 4 times. This would therefore increase the safe distance by a factor of 2. So the formula is modified as:

$$r = \sqrt{\frac{G_{numeric} * Pt}{\pi S}}$$

For the antenna, the Maximum gain≤3dBi =2

For the fixed wireless terminal, the rated power=24dBm (0.25w)

Limits:

S=2.75mW/cm^2 =27.5W/m^2 for controlled exposure

S=0.55mW/cm^2 =5.5W/m^2 for uncontrolled exposure

So:

r=8cm for controlled exposure

r=17cm for uncontrolled exposure

A6 Location of fixed wireless terminal antennas

Fixed wireless terminal Indoor antennas is omni antennas, the source of the radiation, are usually mounted on fixed wireless terminal with TNC converter; The Indoor omni antennas generally parameter is: omni-824-894mhz-2.15dBi-vertical-50W-or-TNC/MALE; Generally the direction of the antenna position is uprightness tabletop, you can adjust the direction of the antenna position basis view the signal strength on the display screen of the fixed wireless terminal.

The highest level of emission would be expected in close vicinity of the antenna and in line of sight to the antenna.

A6.1 Exclusions Zones

1) In an area where signals can be transmitted and received with good quality, you can install an indoor antenna, as shown in Figure 1.

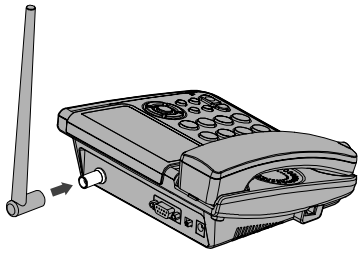

Figure 1 installing an indoor antenna for the fixed wireless terminal

2) Make sure to place the switch of the fixed wireless terminal in the OFF position.

3) Align the indoor antenna with the antenna port on the fixed wireless terminal host in the direction shown in Figure 1, and then screw the antenna, ensuring that the connection is secure.
4) Viewing the signal strength 。You can view the signal strength through the received signal strength indicator on the display screen of the fixed wireless terminal.

A6.2 Guidelines on arranging antenna sites

5) Do not place magnetic storage media such as magnetic cards and floppy disks near the fixed wireless terminal. Radiation from the fixed wireless terminal may erase the information stored on them.
6) Do not put your fixed wireless terminal, battery, or other accessories in containers with strong magnetic field, such as the induction cooker and microwave oven. Otherwise, circuit failure, fire, or explosion may result.
7) When lightning, if you use the power adapter, please turn off the fixed wireless terminal and disconnect the power adapter from external power supply. If outdoor antenna is used, please turn off the fixed wireless terminal and do not touch the interface between fixed wireless terminal and antenna.
8) Do not touch the antenna when a call is going on. Touching the antenna may affect call quality and cause the fixed wireless terminal to operate at a power level higher than needed.
9) The network signal condition will directly affect the quality and stability of the call. Consequently, you should place fixed wireless terminal in a place where it can receive network signal well. Do not put fixed wireless terminal in a building with an iron or metal roof. The distance between fixed wireless terminal and other metal materials (such as metal brackets or metal doors and windows) should be greater than 25cm and the distance between fixed wireless terminals should be greater than 30cm.
10) Your fixed wireless terminal is designed to conform to the authoritative international radio frequency (RF) specifications. Use fixed wireless terminal accessories approved by Huawei only.