

# Environmental Evaluation of RF Exposure

## MAXIMUM PERMISSIBLE EXPOSURE (MPE) ESTIMATION

Prepared for Federal Communications Commission  
**FCC ID: QRM-WEX-10-EXT**

### Introduction

#### **Purpose of the Report**

This technical report is a detailed environmental analysis of the radio frequency exposure expected from use of the Neptune WEX-10 CDPD Wireless Modem, manufactured by WaveCell International Corporation, FCC ID: QRM-WEX-10-EXT frequency range of 824-849 MHz.

The following analysis demonstrate that the product Neptune WEX-10 CDPD Wireless Modem is in compliance with the requirements for maximum permissible exposure (MPE) to radio frequency exposure as defined in the FCC Rules, 47 CFR 2. 1091, as amended and the limits as given in the FCC Rules, 47 CFR 2. 1.1310, table 1, Radio Frequency radiation exposure limits.

#### **Limits**

The criteria listed in the following table are used to evaluate the environmental impact of human exposure to radio frequency (RF) radiation as specified in 1.1307(b).

LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm <sup>2</sup> )
300-1500	...	...	F/300
1500-100,000	...	...	5
300-1500	...	...	F/1500
1500-100,000	...	...	1.0

F=frequency of interest

### Classification of Device/Applicability of Rules

#### **Mobile devices**

The Neptune Wex-10 CDPD Wireless Modem is properly defined as a mobile device per 47 CFR 2.1091 (b), which states that “mobile devices are defined as transmitters designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between radiating antennas and the body of the user or nearby persons.”

Neptune Wex-10 CDPD Wireless Modem is designed to be used in mobile applications. Mounting inside the passenger compartment or trunk is acceptable. The recommended location of the antenna

is on the car roof or a flat ground plane, at least 10 cm away from any uneven surface. When choosing a location for the antenna, consideration is given to metal obstructions.

For applications for the Neptune Wex-10 CDPD Wireless modem, typically at least a separation distance of 20 centimeters is maintained between the radiating antennas and the body of the user or nearby person in order to meet the FCC exposure guidelines while the device is in operation. A statement is included in the User's Manual recommending maintaining a separation distance of 20 centimeter. However, this statement does not in anyway reflects that proximity of less than 20 centimeters are hazardous. The recommendation of a 20-cm separation distance ensures that a well-defined margin with respect to the maximum permissible exposure as estimated using a theoretical prediction model is maintained.

### **Operation mode**

The device is a CDPD wireless modem. Maximum exposure calculation is based on 100% duty factor to calculate for the worst case condition.

### **Estimation/Calculation method of Power Density(S):**

Calculations can be made to predict RF Field strength and power density levels around typical RF Sources. For example, in the case of a single radiating antenna, a prediction for power density in the far field of the antenna can be made by use of the general equations below. These equations are generally accurate in the far field of an antenna but will over-predict power density in the near field, where they could be used for making a worst case or conservative prediction.

$$S = PG/4\pi R^2$$

Where: S= power density, mW/cm<sup>2</sup>

P= power input to the antenna, mW

G= power gain of the antenna in the direction of interest relative to an isotropic radiator R=distance to the center of radiation of the antenna, cm

or:

$$S = EIRP/ 4\pi R^2$$

Where: EIRP = equivalent (or effective) isotropically radiated power

It can be seen from the above that the "worst case" or the max. MPE limit for mobile devices can be estimated according to the power density (S) produced by an isotropic source with radiated output power equivalent to that transmitted by the device as discussed above (OET Bulletin 65).

In this case the operating power is expressed in terms of "ERP" (effective radiated power) instead of EIRP. As such, it is necessary to know the ERP of the source.

The ERP was measured at APREL Laboratories, following the substitution method as described in this text and then converted to EIRP for use in the above equation.

### **Determination of Effective Radiated Power (ERP)**

The radiated RF power measurement was carried out at APREL Laboratory's open area test site (OATS). This open area test site is calibrated to ANSI C63.4 document and a description of the measurement facility is on file with the Federal Communications Commission and is in compliance with the requirement of Section 2.948 of the Commissions rules and regulations. (FCC File No.: 90416)

The Wireless Module was configured to operate at maximum power. The equipment under test was placed on a turntable positioned 3 m away from the calibrated receiving antenna, which in turn was connected to the spectrum analyzer.

For each transmitter frequency, the received signal was maximized by rotating the turntable and adjusting the height of the receiving antenna. To obtain the actual ERP, the DUI was replaced by a vertically polarised half-wave dipole antenna resonant to that frequency and fed by a RF power amplifier and signal generator. The center of the dipole antenna was placed precisely in the same location as the DUI. It was ensured that the orientation of the rotating table and the height of the receiving antenna were unmoved. The signal generator level was adjusted until the peak reading on the spectrum analyzer was identical to that obtained when the DUI was on the turntable. The two signals were matched by superimposing one signal to the other on the spectrum analyzer screen. The output of power amplifier was disconnected from the substitute dipole antenna and connected to a RF power meter. The effective radiated power was read directly from the power meter.

ERP is power referenced to a half-wave dipole radiator instead of to an isotropic radiator. As such, the ERP is converted to EIRP by using the relationship of "1.64" the gains of a half wave dipole antenna relative to an isotropic radiator.

The ERP was measured at high, middle and low channel frequencies. The MPE is calculated on the frequency 849.97 MHz, channel number 799 as it has the highest or maximum ERP which is 0.458 W (458 mW). The at 100% duty cycle (worst case. Then the averaging time is 1/1=1.

**Calculation of MPEs:**

Based on the above ERP, MPE is:

$$\text{max MPEs} = \text{EIRP} / 4\pi R^2$$

$$\text{max} = 1.64 \text{ ERP (mW)} / 4\pi R^2$$

Where:

R= 20 cm (the recommended separation distance as noted in the User's Manual).

$$\text{ERP} = 458 \text{ mW}$$

$$\text{maxs MPEs} = 0.1495 \text{ mW/cm}^2$$

The maximum permissible exposure (MPE) limit for general population/uncontrolled exposure for this band is:  $F/1500 = 848.97/1500 = 0.5659 \text{ mW/ cm}^2$

The maxs MPEs limit =  $0.5659 \text{ mW/ cm}^2$

The max MPEs = 0.1495 mW/ cm<sup>2</sup>

**Conclusion:**

Since the worst case MPE determined above, are much lower than the limits, compliance is demonstrated.

**APPLICABLE DOCUMENTS**

FCC Rule Part 47CFR §2.1091

ANSI/IEEE C95.1-1999, IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3kHz to 300GHz.

ANSI/IEEE C95.3-1992, IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields – RF and Microwave.

OET Bulletin 65 (Edition 97-01) Supplement C (Edition 01-01), Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields.

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