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Maximum Permissible Exposure (MPE) Compliance Statement for the SpotCell 100 (800MHz Cellular) Adaptive Repeater for Uncontrolled Exposure (general population) and Occupational Workers (controlled exposure).

The SpotCell 100 (800MHz) equipment has been tested and the performance characterized in accordance with the MPE requirement of CFR 47, Part 1.1310.

The system is a low power adaptive repeater, having integral antennas built into the CU and DU modules. For the highest frequency of the Cellular Services, 894MHz, the MPE limit for the General Population is 0.6mW/cm^2 (894/1500 = 0.596≈0.6mW/cm^2). For Occupational Workers (controlled exposure), the MPE limit is 3.0mW/cm^2 (894MHz/300 = 2.98mW/cm^2 ≈ 3.0mW/cm^2).

For the DU, with a rated output power of +20dBm and antenna gain of 10dBi, the power density is 0.6mW/cm^2 at a distance of 11.5cm from the antenna. The analysis used is:

S = Power Density = EIRP/($4\pi R^2$)
S= 0.6mW/cm^2 = 1000mW/($4\pi R^2$)

Solving for R, this gives a value of 11.5cm.

For occupational workers, the Maximum Permissible Exposure (MPE) limit is given by 3mW/cm^2, by CFR 47, Part 1.1310. (f/300 mW/cm^2).

The prediction methods provided are based on worst-case far-field calculations:

S = EIRP/($4\pi R^2$),

Where S is power density at a distance R from the radiating element, in mW/cm^2.
EIRP is the radiated power in mW(milliWatts).
R is the distance in cm.

Using this calculation, for the DU of EIRP = 1000mW (30dBm)

S = 3mW/cm^2.
EIRP = 1000mW.
R = 5.2cm

For the CU, a similar analysis is used for a rated output power of +7dBm per RF port and antenna gain of 3dBi. For this release, Spotcell 100 Rel 2.3, the CU has two downlink output RF ports. The main RF port feeds the integral antenna. The second RF port, with MCX connector, shall be used for extended coverage by customers who wish to do so. The RF output from the second port will be conducted via a coax cable to an external antenna with a maximum gain of +3dBi. Spotwave Wireless shall provide the external antenna in a similar housing as the main CU. There will be a maximum of 6dB cable loss and minimum of 1dB cable loss. As a result, the radiated out put power from the external antenna shall always be less than the main antenna.

MPE Analysis:

The distance from the main CU antenna at which the power density is $0.6mW/cm^2$ is 1.15cm for the general public and the distance at which the power density is $3mW/cm^2$ is 0.50cm for occupational persons.

For the main CU:

S = $0.6mW/cm^2$ for the general population and $3mW/cm^2$ for occupational persons.

EIRP = 10mW (10dBm)

Using the prediction method, $S = EIRP/(4\pi R^2)$:

R = 1.15cm for the general population and R = 0.50cm for occupational workers.

The integral radome on CU provides > 1.5cm physical separation from the antenna so that no warning statement is required for this module.

For the external antenna for extended coverage, there will be at least 1dB of cable loss. The external antenna shall have a maximum of +3dBi gain. The maximum EIRP from the external antenna shall be = 8mW (9dBm).

Using the prediction method, $S = EIRP/(4\pi R^2)$:

R= 1.03cm for the general public and R = 0.50cm for occupational workers.

The housing on the main CU and the external antenna provides a separation >1.5cm between the radiating element and the radome and so no warning statement shall be required for both the main CU and the external antenna. The two antennas are never going to be co-located. Spotwave Wireless Inc will make a recommendation, in the

customer manual for the extended coverage KIT, that a minimum of 10meters of separation be applied when the antennas are deployed facing in opposite directions.

When the main CU and the extended coverage antenna are deployed 10cm apart and facing in opposite directions, the back lobe of the radiation from one antenna will be super-imposed on top of the main radiated signal. The main CU antenna and the extended coverage antenna have a Front-to-back (F/B) ratio of 12dB. The additional radiation from the second antenna shall be –3dBm (9dBm –12dB) or –0.5mW. The free space loss for a separation of 10cm and at Maximum frequency of 894MHz is 11dB (calculated below). For this deployment scenario, the MPE calculation shall be:

Free Loss = 32.44+20log(f)+20log (d), f in MHz and d is in Km.
= 32.44+20log(894)+20log 10^{-4} = 11.0dB.
EIRP in front of main antenna due to external antenna = 9dBm – 12dB – 11dB = -14dBm = 0.04mW
Total EIRP = 10.04mW
0.6mW/cm^2 = (Total EIRP)/ ($4\pi R^2$) = 10.04mW/($4\pi R^2$), for the general public and
3mW/cm^2 = (Total EIRP)/ ($4\pi R^2$) = 10.04mW/($4\pi R^2$), for occupational persons.

Solving for R gives a distance of 1.15cm for the general public and a distance of 0.52cm for occupational persons. This is still below the 20cm safety margin required.

Worst Case scenario:
In an unlikely scenario, if the two antenna are separated by 10cm and facing in the same direction, the total EIRP in front of the main CU due to the external antenna shall be: 10mW (from the main CU) + 0.6mW (from external antenna).

The EIRP from the external antenna in front of the main CU is calculated as follows:

9dBm – 11dB (due to free space of 10cm) = -2dBm = 0.6mW.

MPE distance for this scenario is:

0.6mW/cm^2 = (Total EIRP)/ ($4\pi R^2$) = 10.6mW/($4\pi R^2$), for general public.
3mW/cm^2 = (Total EIRP)/ ($4\pi R^2$) = 10.6mW/($4\pi R^2$), for occupational persons.

Solving for R gives a distance of 1.18cm for the general public and 0.53cm for occupational persons. Not that this type of deployment is not recommended by Spotwave Wireless Inc. This calculation is included to show that even in the worst case type of deployment the safety requirement within the 20cm distance is met.

MPE Limits Summary:

DU: 11.50cm for the general public and at 5.20cm for occupational workers.
CU: 1.15cm for the general public and at 0.50cm for occupational workers.
External antenna: 1.03cm for the general public and at 0.50cm for occupational workers.
CU and External Antenna 10cm apart and facing in opposite direction: **1.15cm for the general public and 0.52 cm for occupational persons.**
CU and External Antenna 10cm apart and facing in same direction: **1.18cm for the general public and 0.53 cm for occupational persons.**

The User Manual, which also incorporates the installation instructions, includes a warning statement on page (i) of the document under the heading "Important Safety Information". The warning instructs the installer to ensure the DU is mounted in a location where people will not approach within 1meter of the front of the unit. This distance provides additional safety margin for the product. The User Manual also states that the CU should be mounted in locations where people will not approach within 20cm of the front of the CU. The extended coverage KIT manual also states the minimum separation required between the main CU and the external antenna. This distance is 10centimeters and the CUs should be facing in opposite directions.

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