RF Exposure Calculations for FCCID:CASTBAB1

Antenna type:

The antenna normally used with VHF paging transmitters is a vertically polarised collinear type about 3 m long. Gain is typically about 6dBi.

Safe Distance Calculations:

Using Tell's near field equation[1]:

Eq 1: $S = Pnet / (2 \pi R h)$

Re arrange to solve for R:

Eq 2: $R = Pnet / (2 \pi S h)$

For uncontrolled environment S = 0.2 mW per cm^2

For 100 watts:

$R = 100 \times 1000 / (2 \pi \times 0.2 \times 3 \times 100)$

$R = 265.3$ cm

For 50 watts:

$R = 50 \times 1000 / (2 \pi \times 0.2 \times 3 \times 100)$

$R = 132.6$ cm

For 5 watts:

$R = 5 \times 1000 / (2 \pi \times 0.2 \times 3 \times 100)$

$R = 13.2$ cm

Using the standard far field equation[2]:

Eq 3: $S = P G / 4 \pi R^2$

Re-arrange to solve for R:

Eq 4: $R = \sqrt{(P G / 4 \pi S)}$

For uncontrolled environment S = 0.2 mW per cm^2

$R = \sqrt{(100 \times 1000 \times 3.98)/ (4 \pi \times 0.2)}$

$R = 397.9$ cm

Where S = power density in mW per cm^2
P, Pnet = net power input to the antenna in mW
R = distance from the antenna in cm
h = aperture height of the antenna in cm
G = linear gain of antenna relative to an isotropic radiator

Far field boundary calculations:

Calculating the far field boundary distance[3]:

Eq 5: Far field distance $\geq 2(d1 + d2)^2 / \lambda$

Where d1 = largest dimension of transmitting antenna in metres

d2 = largest dimension of receiving antenna (standing human figure) in metres
λ = wavelength at highest frequency of operation, 174 MHz

Far field distance $\geq 2 (3 + 1.8)^2 / (300{,}000{,}000 \times 1/174{,}000{,}000)$

Far field distance ≥ 26.7264 m.

Calculating the power density at the far field boundary:

Eq 3: $S = P G / 4 \pi R^2$

For uncontrolled environment S = 0.2 mW per cm^2

$S = 100 \times 1000 \times 3.98 / (4 \pi \times 26726.4^2)$

S = 0.000044 mW per cm^2

Conclusion:

The safe distance for the uncontrolled environment limit of 0.2mW per cm^2 was calculated using Tell's near field formula and the standard far field formula. As expected, the standard far field formula over predicts the power density, giving a safe distance of 3.98 metres compared to the near field result of 2.65 metres.

In order to determine which safe distance to recommend, the far field boundary distance was calculated and found to be 26.7 metres.

The near field safe distance of 2.66 metres applies as the near field extends from the antenna to the far field boundary 26.7 metres from the antenna. At 26.7 metres the power density calculated by the far field calculation is 0.000044 mW per cm^2 which is much smaller than the limit of 0.02 mW per cm^2.

This result shows that the FCC MPE requirements for the product are met provided users obey the instructions in the instruction manual, which recommend maintaining a minimum safe distance of 2.66 metres from the antenna.

References:

1. OET Bulletin 65 page 32
2. OET Bulletin 65 page 19
3 ETSI TR 102 273-1-2 V1.2.1 (2001-12) p 180