Additional MPE exhibit for Teltest Report 2229 RF Exposure Calculations for FCC ID:CASTBAL0

Antenna type:

The antennas normally used with 900 MHz UHF paging transmitters are vertically polarised collinear types with typical lengths of 1.1, 1.6 and 2.7 m, and gains of 5dBi, 8.4dBi, and 11 dBi respectively[1]. MPE calculations for each type are given below.

Safe Distance Calculations for 1.1 metre 5 dBi antenna[1]:

Using Tell's near field equation[2]:

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 $S = f/1500$ mW per cm^2
$S = 0.62$ mW per cm^2

For 100 watts:

$R = 100 \times 1000 / (2 \pi \times 0.62 \times 110)$

$R = 233.9$

Using the standard far field equation[3]:

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 $S = f/1500$ mW per cm^2
$S = 0.62$ mW per cm^2

$R = \sqrt{(100 \times 1000 \times 3.16)/ (4 \pi \times 0.62)}$

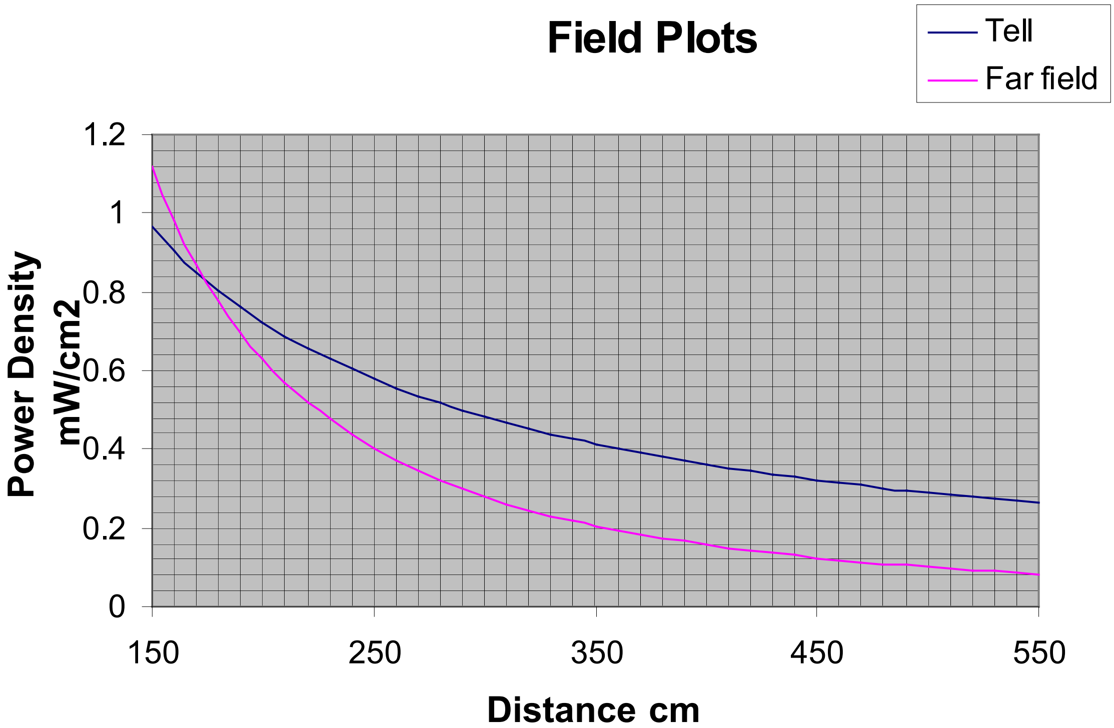
$R = 202$ cm

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
f = Frequency in MHz

Far field boundary calculations:

Calculating the far field boundary distance[3]:

Tell's equation applies for several metres from the antenna[3], but may over predict the power density at longer distances. To determine which result should be used, plots of power density using Tell's and the conventional far field equations are plotted. The crossover point shows the transition between near and far field regions. In the plot below, the transition occurs at about 172 cms. Hence the result for the far field calculation applies in this case.



Conclusion:

The safe distance for the uncontrolled environment limit of 0.62mW per cm^2 was calculated using Tell's near field equation (2.34 m) and the standard far field equation (2 m). To determine which result applies, power densities in the range 1.5 to 4.5 metres were plotted for both methods. The crossover point was used to determine the transition point from near field to far field. This point was about 1.72 metres from the antenna. Since both Tell's and far field equations gave results in the far field for a power density of 0.62 mW per sq cm, the applicable result was the far field distance, 2 m.

Field Region	Distance	Tells Equation	Far Field Equation
Near Field	0-1.72 metres	Applies	Does not apply
Far Field	>1.72 metres	Does not apply	Applies

This result shows that the FCC MPE requirements for the product are met provided users obey the instructions supplied, which recommend maintaining a minimum safe distance of 2 metres from the antenna.

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Safe Distance Calculations for 1.6 metre 8.4 dBi antenna[1]:

Using Tell's near field equation[2]:

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 $S = f/1500$ mW per cm^2
$S = 0.62$ mW per cm^2

For 100 watts:

$R = 100 \times 1000 / (2 \pi \times 0.62 \times 160)$

$R = 160.8$

Using the standard far field equation[3]:

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 $S = f/1500$ mW per cm^2
$S = 0.62$ mW per cm^2

$R = \sqrt{(100 \times 1000 \times 6.92)/ (4 \pi \times 0.62)}$

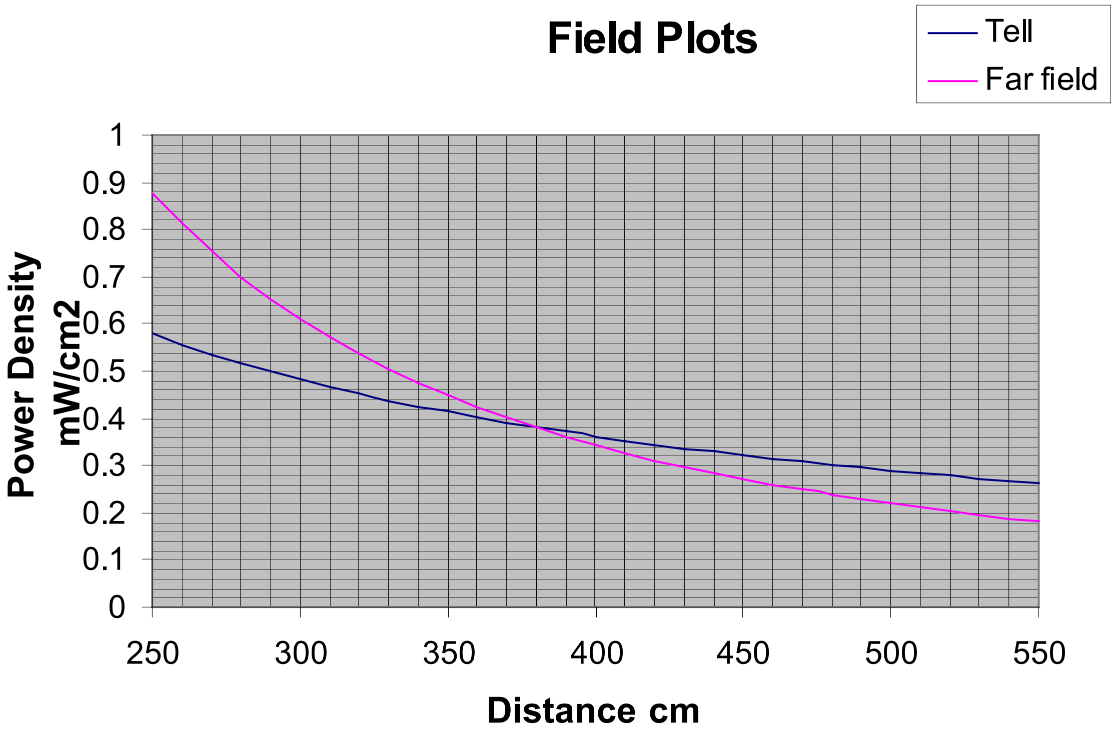
$R = 298.3$ cm

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
f = Frequency in MHz

Far field boundary calculations:

Calculating the far field boundary distance[3]:

Tell's equation applies for several metres from the antenna[3], but may over predict the power density at longer distances. To determine which result should be used, plots of power density using Tell's and the conventional far field equations are plotted. The crossover point shows the transition between near and far field regions. In the plot below, the transition occurs at about 380 cms. Hence the result for the near field calculation applies in this case.



Conclusion:

The safe distance for the uncontrolled environment limit of 0.62mW per cm^2 was calculated using Tell's near field equation (1.61 m) and the standard far field equation (2.98 m). To determine which result applies, power densities in the range 2.5 to 5.5 metres were plotted for both methods. The crossover point was used to determine the transition point from near field to far field. This point was about 3.8 metres from the antenna. Since both Tell's and far field equations gave results in the near field for a power density of 0.62 mW per sq cm, the applicable result was the near field distance, 1.61 m.

Field Region	Distance	Tells Equation	Far Field Equation
Near Field	0-3.8 metres	Applies	Does not apply
Far Field	>3.8 metres	Does not apply	Applies

This result shows that the FCC MPE requirements for the product are met provided users obey the instructions supplied, which recommend maintaining a minimum safe distance of 1.61 metres from the antenna.

Safe Distance Calculations for 2.7 metre 11 dBi antenna[1]:

Using Tell's near field equation[2]:

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 $S = f/1500$ mW per cm^2
$S = 0.62$ mW per cm^2

For 100 watts:

$R = 100 \times 1000 / (2 \pi \times 0.62 \times 270)$

$R = 95.3$

Using the standard far field equation[3]:

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 $S = f/1500$ mW per cm^2
$S = 0.62$ mW per cm^2

$R = \sqrt{(100 \times 1000 \times 12.6)/ (4 \pi \times 0.62)}$

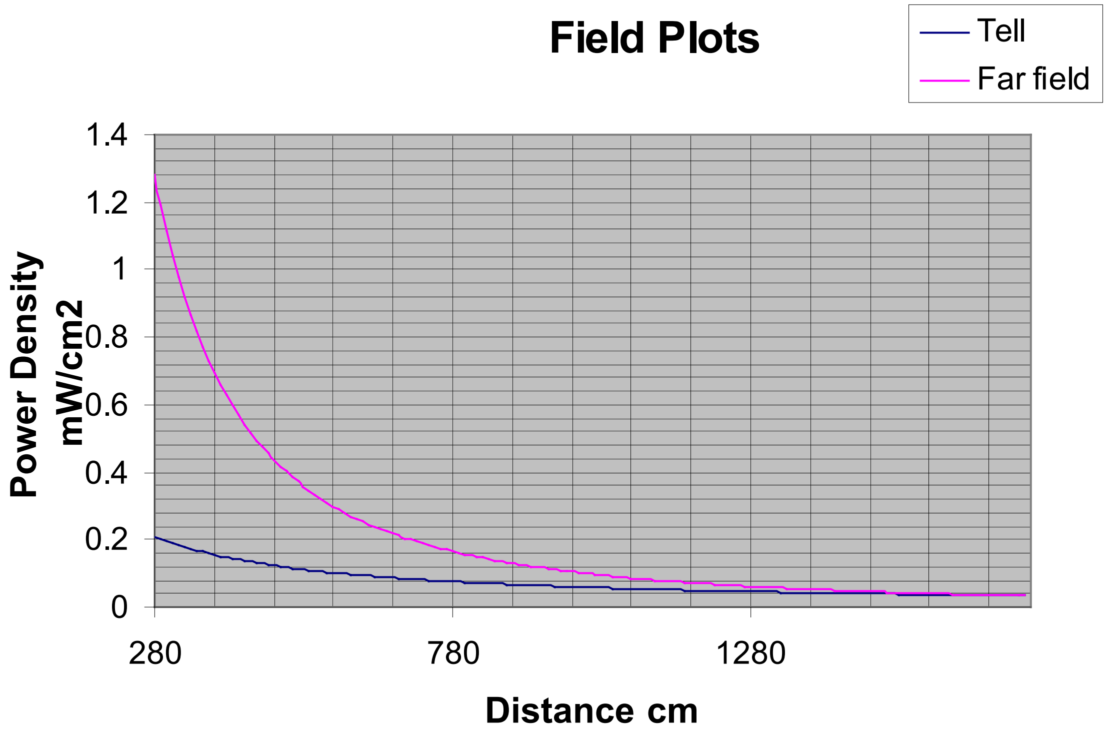
$R = 402.4$ cm

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
f = Frequency in MHz

Far field boundary calculations:

Calculating the far field boundary distance[3]:

Tell's equation applies for several metres from the antenna[3], but may over predict the power density at longer distances. To determine which result should be used, plots of power density using Tell's and the conventional far field equations are plotted. The crossover point shows the transition between near and far field regions. In the plot below, the transition occurs at about 1700 cms. Hence the result for the near field calculation applies in this case.



Conclusion:

The safe distance for the uncontrolled environment limit of 0.62mW per cm^2 was calculated using Tell's near field equation (0.95 m) and the standard far field equation (4 m). To determine which result applies, power densities in the range 2.8 to 17.8 metres were plotted for both methods. The crossover point was used to determine the transition point from near field to far field. This point was about 17 metres from the antenna. Since both Tell's and far field equations gave results in the near field for a power density of 0.62 mW per sq cm, the applicable result was the near field distance, 0.95 m.

Field Region	Distance	Tells Equation	Far Field Equation
Near Field	0-16.9 metres	Applies	Does not apply
Far Field	>16.9 metres	Does not apply	Applies

This result shows that the FCC MPE requirements for the product are met provided users obey the instructions supplied, which recommend maintaining a minimum safe distance of 0.95 metres from the antenna.

Information relating to Maximum Permissible Exposure Safe Distances:

Table of Safe Distances for representative Collinear Antennas:

Transmitter Power 100 watts		
Antenna Gain dBi	**Antenna length in cm**	**Safe Distance in metres for Uncontrolled Environment**
5	110	2
8.4	160	1.6
11	270	0.95

References:

1. RFI Industries Pty Ltd, *800 MHz Collinear Antennas*, data sheet P-37753-2, P-37722-1, P-37753-1.
2. FCC OET Bulletin 65 Edition 97-01, *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields*, p. 32
3. FCC OET Bulletin 65 Edition 97-01, *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields*, p. 19
4. FCC OET Bulletin 65 Edition 97-01, *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields*, p. 31

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