Measurements of the Effectiveness of Antenna Screens for Protection of the Head from Mobile Phone Radiation

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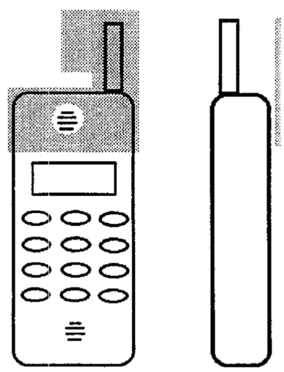
Abstract: Measurements have been taken of the electromagnetic field distribution around a mobile phone which was transmitting CW at 890 MHz. The measurements were taken using a mobile phone with a short monopole antenna and were then repeated with a reflector (that is supposed to protect the head from radiation) interposed between the head and the radiating antenna. Measurements of field magnitude and phase were made so that animations of the propagating fields could be observed. Comparisons of the field distributions and conclusions regarding the effectiveness of the reflector could then be made.

INTRODUCTION:

There are concerns about the health effects of absorption by the head of electromagnetic energy when people use mobile phones. There are several systems on the market that purport to reduce this absorption. A typical system is shown in Figure 1 where a flexible metal reflector is included with the mobile phone case. This reflector can be folded out of the way when the phone is not in use. When the mobile is used the reflector is unfolded and is positioned between the antenna and the user's head with the intent of reflecting away from the head some of the antenna radiated energy that would otherwise be directed at it.



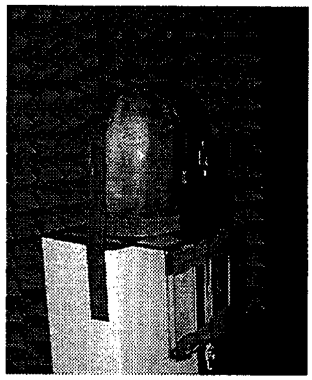
The mobile telephone with a reflector (shown in grey) in front of the stub antenna
Figure 1

This study examines how well such a reflector reduces the radiated electromagnetic field levels in the head of the phone user. (The question of the effect on the mobile phone's performance is not considered.)

In order to do this the radiated field distribution of the mobile phone antenna transmitting CW at 890 MHz. next to a simulated head was measured with and without the presence of an antenna reflector.

MEASUREMENT METHOD.

The measurements were conducted in an anechoic chamber at one end of which was located a mobile phone next to a simulated head. (See Figure 2)



Simulated Head with mobile telephone
Figure 2.

Field distribution measurements external to the model head were taken in a series of azimuth patterns. with the mobile phone transmitting CW. A receiving antenna was located on a radial line from the centre of rotation at a different fixed radial distance for each azimuth plot. The series of azimuth plots were used to compile the field distribution in the area about the head. The field strength measurements had been taken at one degree azimuth spacing and one eighth of a wavelength radial spacing

For the near field measurements internal to the model head the same arrangement was used except that the head was supported from above and was held stationary whilst the mobile phone was rotated about it. The probe antenna (with element length adjusted to maintain the same electrical length and return loss as for the external measurements) was injected into the core of the head at separate points along the fixed radial line for each azimuth plot. Again the various azimuth plots were compiled, this time to give the field distribution inside the head. The measurements were made using an HP8753A vector network analyser and both magnitude and phase of the received signals were recorded.

The object of the exercise was to measure the change to the field distribution caused by the introduction of the reflector between the head and the antenna of the mobile phone, not to give an accurate measure of the field distributions inside a real head. It has been shown in computer simulations of mobile phone to head interactions [1] that a sphere of appropriate dielectric and size models the head well in terms of the overall signal strengths inside it even if the exact field distribution is not replicated. Thus for this exercise the model used for the head was a watermelon of about head size and shape. It had approximately the correct permittivity and was reasonably homogeneous except for a hard outer surface. This surface was easily drilled to permit the insertion of the probe antenna.

RESULTS

The measured vertically polarised electric field distributions in and around the model head in a horizontal plane through the centre of the head are shown in Figures 3 (a), (b), (c) and (d).

Figures 3 (a) and (b) show the electric field distribution when there is no antenna reflector. Figures 3 (c) and (d) show the electric field distribution when a reflector is introduced between the antenna and the model head. (3 (a) and (c) are of instantaneous field strength normalised to a common level and 3 (b) and (d) are of RMS field strength in dB relative to a common level) Positive and negative instantaneous field values refer to the instantaneous field direction up or down.

The area shown in the figures is 112 cm (3.32λ) in diameter with the 23 cm diameter head in the middle surrounded by a black band where no measurements could be taken due to the mounting scheme.

The instantaneous values were obtained from the measured magnitude and phase values and could be produced for any reference phase angle. Thus instantaneous field distributions at stepped time intervals could be produced to create animations [2] of the measured propagating electric field in and around the head. Animations of these propagating fields in and around the head will be shown at the conference.

Examination of the RMS and instantaneous field distributions showed that they were basically unaltered by the presence or lack of the reflector between the antenna and the head. What was evident is a uniform level drop of about 2 dB when the reflector was introduced. This was due to the reflector affecting the antenna impedance and this varied depending on the antenna to reflector separation.

CONCLUSIONS:

The antenna reflector tested did little to redirect radiated energy away from the head. Less energy would be absorbed by the head if the reflector was used but a similar result could be obtained by transmitting less power and still using the mobile phone antenna with no reflector.

REFERENCES:

[1] M. A. Jensen and Y. Rahmat-Samii, "EM Interaction of Handset and a Human in Personal Communications", in *Proceedings of the IEEE,* Vol. 83 No. 1, pp 7-17, Jan. 1995.

[2] S. C Jenvey, "Visualising radio propagation inside buildings," in *Proceedings of the 47th IEEE Vehicular Technology Conference,*pp 2080-2083, Phoenix, Arizona, May 1997.

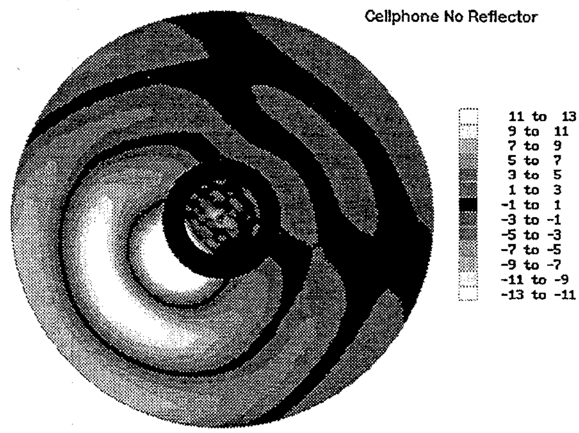


Figure 3(a)

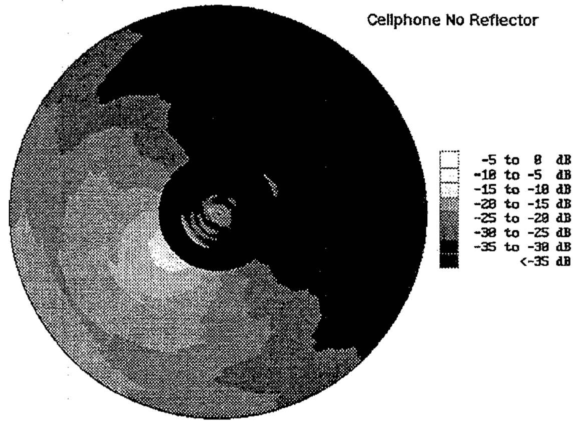


Figure 3(b)

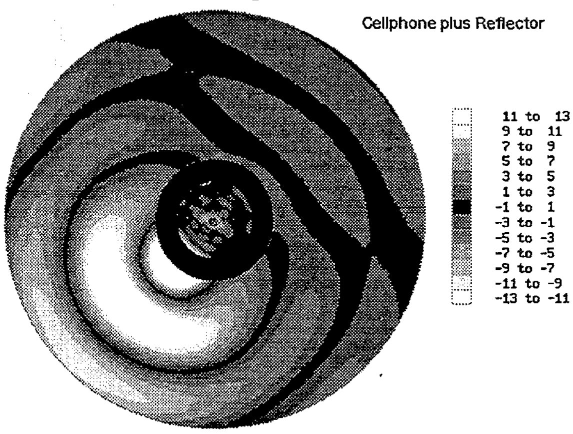


Figure 3(c)

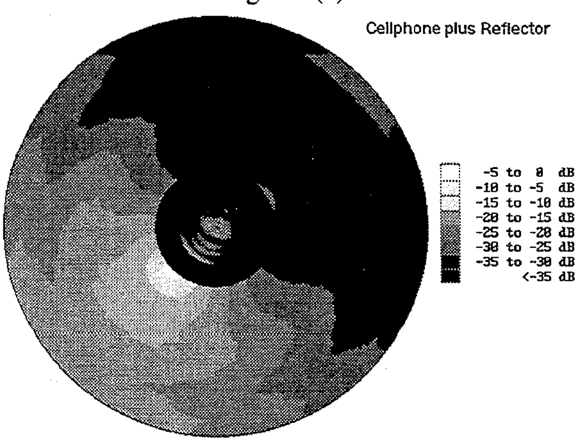


Figure 3(d)