1. Sobel, E., Davanipour, Z., Sulkava, R., Erkinjuntti, T, Wikstrom, J.,Henderson, VW., Buckwalter, G., Bowman, JD and Lee, P. (1995). Occupations with exposure to electromagnetic fields: a possible risk factor for Alzheimer disease. Am J Epidemiol 142(5): 515-524.

2. Zecca, L., Cerretelli, P. and Mantegazza, C. (1998). Biological effects of prolonged exposure to elf electromagnetic fields in rats: 111. 50hz Electromagnetic fields. Bioelectromagnetics ,19: 57 66.

3. Margonato, V., Nicolini, P., Conti, R., Zecca, L., Veicstanas, A. and Cereyelli, P. (1995). Biological effects of prolonged exposure to ELF electromagnetic fields in rats: 111: 50Hz magnetic fields. Bioelectrmagnetics, 16: 343-355.

PB-6 *DISTURBANCE OF ELECTROMAGNETIC FIELD OF BASE STATION BY PROBES ABOVE GROUND PLANE

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Objective. To obtain an accurate estimation of human exposure around base station antennas, the electromagnetic fields should be analyzed over the body of a person [1], [2]. Such measurements are not possible for practical in-the-field measurements: this would be much too time-consuming. Electromagnetic exposure measurements are mostly performed at a single point resulting in a less accurate estimate of the actual exposure. Knowledge of the field at different locations in a plane or over a vertical line, representing the length of an average human results in a better estimate of the exposure [2]. However, close to the ground plane, the measurement probe will be disturbed. This disturbance cannot be fully taken into account by the calibration. The objective of this paper is to select a suitable measurement probe with maximum sensitivity and a disturbance, which is limited to a predefined value (e.g., 5 %).

Methods. We will analyse an exposure “measurement”in the neighbourhood of a K736863 GSM base station using simulations with NEC-Win-Pro® (based on the Method of Moments). The K736863 antenna with an input power of 20 W radiates at 900 MHz and is positioned 30 m above a ground plane. The “measurements”will be performed as a function of the height from 1 cm to 1.75 m above the ground at 200 m from the base station antenna. This configuration represents a realistic exposure situation for the general public. The configuration and coordinate system are shown in Fig. 1 (not to scale).
The dipoles under study will be noted as Dy (Dy stands for dipole with length y times the wavelength at 900 MHz). Different dipole probes are investigated with a length of 1 cm (D0.03λ), 3 cm (D0.10λ), 7.5 cm (D0.23λ), 11.3 cm (D0.34λ) and 15 cm (D0.45λ), respectively. The radius of the wire of the dipoles is 1.8 mm.

Fig. 2 shows the flow graph of the procedure to study the disturbance of a field probe near an interface. First the true field of the transmitting antenna Tx, noted as E^{true}, is

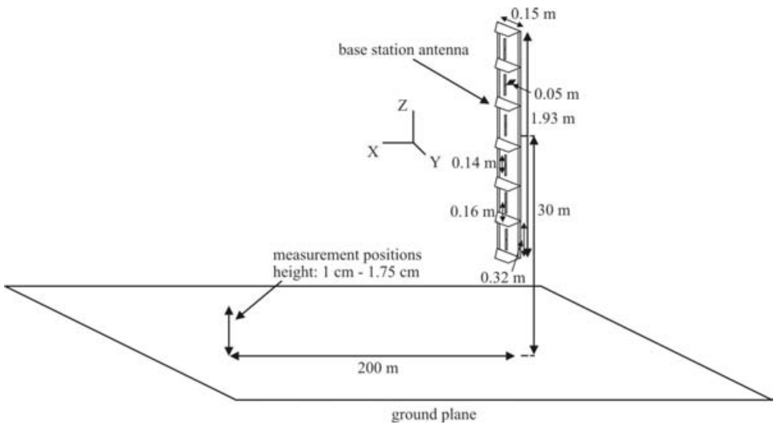

FIGURE 1. Configuration under study.

simulated. Next, the measurement probe (Rx) is calibrated using a two-antenna method and the antenna factor (AF) is determined. Once the measurement probe is calibrated the field of the Tx can be measured. The measurement probe is terminated with a 50 Ω resistance and the "measured" voltage is determined. Using the antenna factor, the "measured" field, noted as E^{meas}, is obtained. The disturbance $\Im$ [%], defined as the relative deviation of fields measured by the probe with respect to the true field, is then determined as the following:

$$\Im = 100 \cdot \frac{E^{true} - E^{meas}}{E^{true}}$$

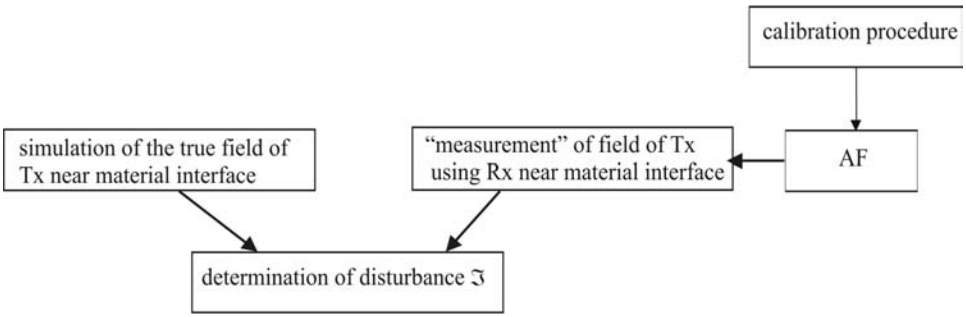

FIGURE 2. Flow graph of the followed procedure.

Results. To obtain frequency-dependent measurements a spectrum analyzer (SA) is used. The noise floor of e.g., the HP8561B spectrum analyser is -70 dBm when a resolution bandwidth of 300 kHz is used. Taking a required signal-to-noise ratio of 10 dB into account and using the antenna factors of the Rx, results in a treshold value for the electric field for the different Rx. Fig. 3 shows the true total electric field E_{tot}^{true} and the corresponding treshold values E_{th} for the different Rx. This figure shows that D0.03λ is not sufficiently sensitive to perform the measurements with a SA ($E_{th}|_{D0.03\lambda} > E_{tot}^{true}$). D0.1λ is only sensitive enough in some specific ranges of heights. The other dipoles are sufficiently sensitive to perform the measurements for the different heights above the ground plane. This figure also shows that the field values are below the reference levels for exposure of the general public: the maximum (0.23 V/m) and average (0.16 V/m) electric field in the considered range of heights are about 180 and 260 times below the ICNIRP reference level of 41.3 V/m [1], respectively.

Fig. 4 shows the disturbance $\Im$ for different Rx as a function of the height above the ground. Also the lines of $\Im$ equal to 1, 5, and 10 % are shown. The disturbance is maximally close to the ground plane and has a local maximum at about 60 cm. This figure shows that lower deviations occur when smaller Rx are used.

The results presented in Fig. 3 and Fig. 4 show that a trade-off has to be made between sensitivity and disturbance. For this specific configuration we make the following conclusions. For heights from 1 cm up to 28 cm, D0.1λ is a suitable measurement probe if $\Im < 5\%$ is required because this Rx is sufficiently sensitive up to 28 cm (Fig. 3 and 4). Above 28 cm, D0.23λ, which is more sensitive than D0.1λ, can be used when disturbances lower than 5 % are required. For heights larger than 62.2 cm and $\Im < 5\%$, D0.45λ – which is the most sensitive Rx – is the optimal measurement probe. If only disturbances smaller than 10 % are required, then D0.45λ can already be used from 10.4 cm above the ground plane for this configuration.

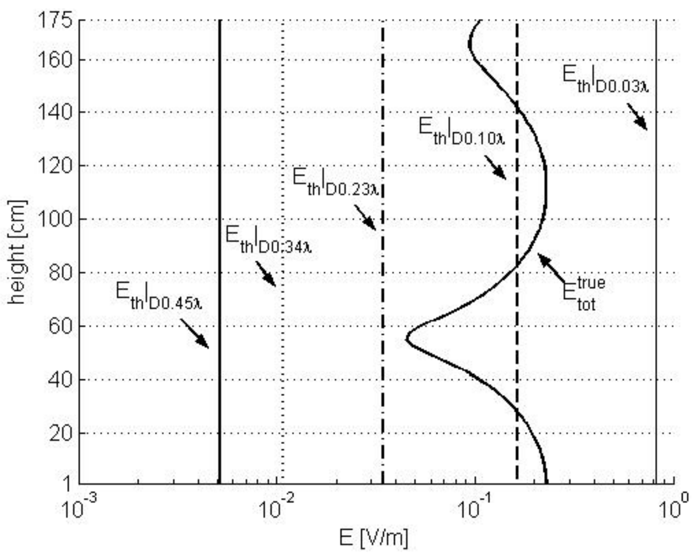

FIGURE 3. The true electric field at 200 m from the 900 MHz-base station antenna with an input power of 20 W as a function of the height above the ground plane and the treshold value for the different Rx.

Conclusions. We have shown that for an electromagnetic exposure measurement in the neighborhood a base station antenna above a ground plane, a suitable measurement probe can be selected. Near the ground plane a trade-off between the disturbance and the sensitivity of the measurement probe will have to be made. For distances high above the ground plane, one can select larger and more sensitive measurement probes.

References.

- International Commission on Non-ionizing Radiation Protection, Guidelines for limiting exposure to time-varying electric,magnetic, and electromagnetic fields (up 300 GHz), Health Physics, Vol. 74, No. 4, pp. 494-522, 1998.
- CENELEC EN50383, Basic standard for the calculation and measurement of electromagnetic field strength and SAR related to human exposure from radio base stations and fixed terminal stations for wireless telecommunication systems (110 MHz 40 GHz), Sept. 2002.

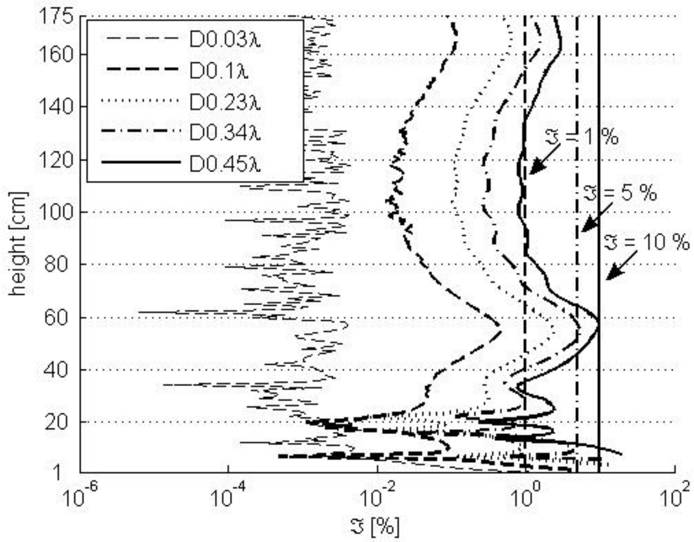

Figure 4. Disturbance of the different probes as a function of the height above the ground plane.

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PB-8 A GAIN MEASUREMENT OF ANTENNAS IN THE TISSUE EQUIVALENT LIQUID FOR THE SAR-PROBE CALIBRATION

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