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P-B-23 STUDENT

**GENERAL CORRECTION FACTOR TO BE APPLIED TO THE SAR FOR OCCUPATIONAL ELECTROMAGNETIC EXPOSURE IN PHANTOM MODELS.** W. Joseph, L. Martens. Dept of Information Technology, Ghent Univ, Sint-Pietersnieuwstraat 41, Ghent, Belgium.

**Objective:** If one determines the safety distances for occupational electromagnetic exposure of e.g., base station antennas, the Specific Absorption Rate (SAR [W/kg]) has to be determined and be compared to the basic restrictions [1]. The SAR is experimentally determined in homogeneous phantoms, which may result in lower SAR values than the SAR in a heterogeneous and anatomically realistic model. Therefore the measured SAR must be multiplied by a correction factor [2]. We will show in this paper that if one wants to obtain a fully conservative approach (i.e., producing a higher SAR), a correction factor which depends on the type of polarization, frequency, and phantom has to be defined. By considering the highest correction factor of the investigated polarizations a conservative approach is assured.
**Methods:** We investigate electromagnetic plane-wave excitation with different polarizations incident on a homogeneous rectangular box phantom (corresponds to the average trunk of an adult man, CENELEC [2]), a homogeneous prolate spheroid phantom (average man [3], widely used simplified model of a human) and a realistic heterogeneous model of a man (Visible Human, developed at Brooks Air Force Base Laboratories). For the box and spheroid phantom the dielectric parameters are those of muscle tissues at the investigated frequencies. Three different polarizations, E-polarization (electric field parallel to the major axis of the spheroid or to the longest dimension of other phantoms), H-polarization (magnetic field parallel to major axis), and K-polarization (direction of incidence along the major axis) have been considered and for each polarization, the whole-body SAR for the three phantoms has been calculated using Finite-Difference Time-Domain (FDTD) simulations and theoretical calculations. We investigate a frequency range of 10 MHz up to 2000 MHz. We define the correction factor Σ for the three different polarizations as the ratio of the whole-body SAR in the human model and the whole-body SAR in the different phantoms:

$$\Sigma\Big|_{\text{phantom}} = \left.\frac{\text{whole}-\text{body SAR}_{\text{human}}}{\text{whole}-\text{body SAR}_{\text{phantom}}}\right|_{u-\text{polarisation}}$$

with u = E, H or K.
To assure a fully conservative approach the maximum value of Σ for the three considered polarizations has to be used. If one combines these three polarizations, every possible incident field polarization can be obtained and thus using the maximum value avoids underestimation of the SAR. Σ is based on the whole-body SAR, which is the best and most restrictive parameter to take the influence of a phantom

into account using plane-wave excitation. The advantage of using the correction factor Σ is that for measurements and simulations of the SAR a simple and homogeneous phantom can be used and by applying Σ realistic worst-case SAR values can be obtained.

**Results:** Fig. 1 and 2 show Σ for the three polarizations for the rectangular box phantom and the spheroid phantom, respectively. We can clearly see that Σ is frequency- and polarization-dependent. These figures show that Σ for E-polarization has mostly the largest values. For frequencies higher than 500 MHz, Σ varies much less than at lower frequencies. Σ reaches a minimum for the different phantoms and polarizations due to resonance. For E-polarization for example, 73 MHz is the resonance frequency of the spheroid phantom in free space. For the rectangular box phantom Σ is of the same order for the three polarizations for frequencies higher than 500 MHz but E-polarization delivers for almost all frequencies the highest correction factor. For the spheroid phantom Σ is higher for H- and K-polarization than for E-polarization for frequencies lower than 400 and 280 MHz, respectively. Fig. 1 shows that for frequencies higher than 500 MHz, Σ is larger than 2 for the box phantom. This shows that the arbitrary factor 2 of CENELEC standard 50383 is not a good choice for the rectangular box phantom. We advise to use for each type of phantom the highest value of Σ of the three polarizations at the considered frequency to obtain a conservative approach.

**Conclusions:** A correction factor for the determination of the SAR in a homogeneous phantom exposed in occupational conditions is presented. The correction factor is frequency, phantom, and polarization dependent. To assure a conservative approach, the highest correction factor of the investigated polarizations (E, H and K) has to be used.

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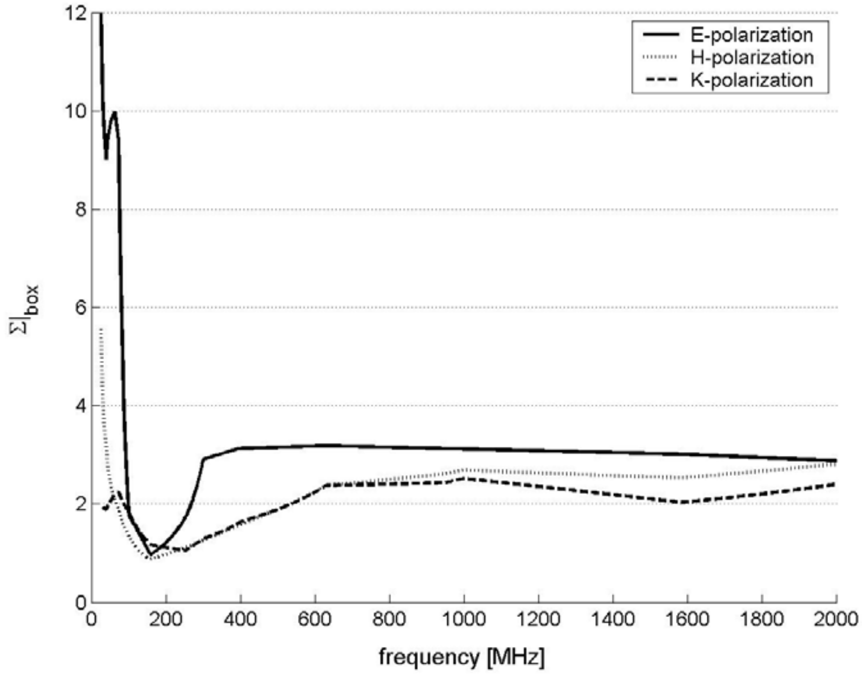


Figure 1: Σ for the rectangular box phantom as a function of the frequency from 10 MHz to 2000 MHz for the three polarizations under study.

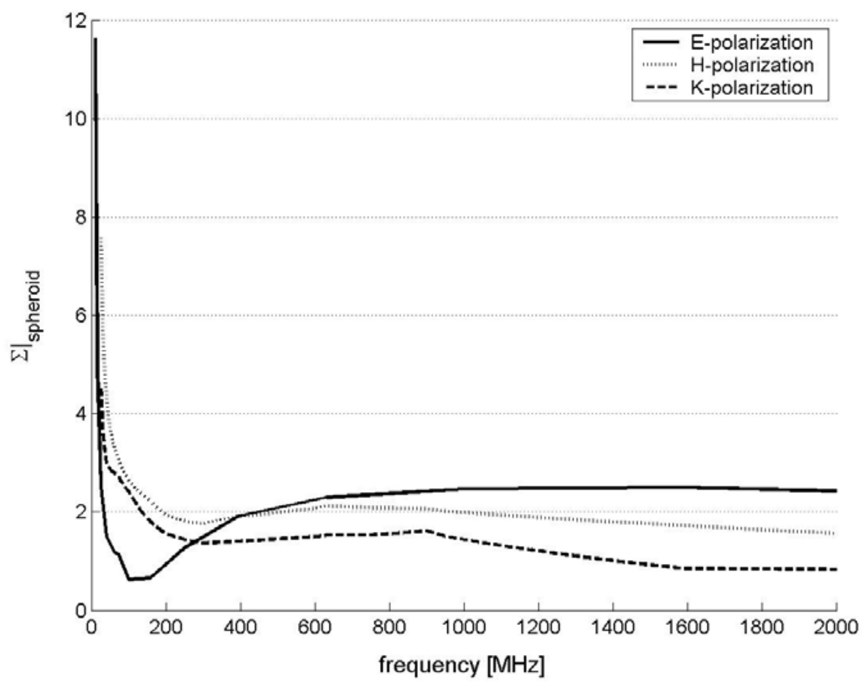


Figure 2: Σ for the spheroid phantom as a function of the frequency from 10 MHz to 2000 MHz for the three polarizations under study.

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