Assessment of Field Exposure by Electronic Article Surveillance Systems

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INTRODUCTION

Electronic article surveillance (EAS) systems are used in many applications to prevent theft in boutiques, shops, supermarkets, and libraries. They produce electromagnetic energy to create an electromagnetic interrogation zone. An EAS system consists of two parts: the detection gates (detectors) where people walk through, and the activators/deactivators for (de)activating the tags. Up to now only limited research concerning the assessment of in-situ exposure (i.e., exposure due to EAS systems installed in e.g., shops) has been performed. Exposures due to the (de)activator part of the EAS system are missing. The objective of this paper is to assess general public exposure to in-situ EAS systems for *both* the detection gate panels and the activators and deactivators. Safety distances for the general public – defined as the distances outside which the field levels of the EAS systems do not exceed the ICNIRP reference levels – are determined. Additionally, temporal and frequency behavior, and signal waveforms are investigated. Finally, exposure ratios, quantifying how many times the fields exceed or are below the ICNIRP reference levels, are provided.

MATERIALS AND METHODS

Three categories of systems are considered here, namely, electromagnetic (EM) systems (typically in range 10 Hz – 20 kHz), acousto-magnetic (AM) systems (20 – 135 kHz), and radiofrequency (RF) systems (1 – 20 MHz)[**Error! Reference source not found.**]. For each category two systems have been investigated in-situ. The EM systems were located in a library and book shop, the AM systems in furniture and music shops, and the RF systems in a supermarket and grocery shop. The waveforms for the EM, AM, and RF systems were continuous wave (CW), pulse modulated (PM), and frequency modulated (FM), respectively. The measurements were performed in the period January - April 2010.

For the EM systems, the fields are measured using an electric- and magnetic-field analyzer of type PMM EHP-50C (Narda Safety Test Solutions). The maximal frequency range setting of the PMM EHP-50C probe is 5 Hz up to 100 kHz. For the AM and RF systems, the fields are measured using an electric- and magnetic-field analyzer of type PMM EHP-200 (Narda Safety Test Solutions). The maximal frequency range setting of the PMM EHP-200 probe is 9 kHz up to 30 MHz. Magnetic fields are measured (partly) according to the European Committee for Electrotechnical Standardization (CENELEC) standard EN 50364 [2].

RESULTS

Fig. 1 shows a 3D image of the spatial measurements over 17 points for AM system III. It can be seen from Fig. 1 that the reference levels (for this AM system 5 A/m) for most spatial locations of the grid are exceeded. For this case values up to about 42.4 A/m were measured at the lowest height of 85 cm. The spatial averaged field H_{avg} equals 25.8 A/m, exceeding thus the 5 A/m ICNIRP reference level.

Table 1 summarizes the results as root-mean-square values (RMS) of the magnetic fields H in A/m. For the detection gates, H_{avg} (over the spatial grid [2]) exceeds the reference levels for 5 of the 6 systems. Only RF system V (supermarket) satisfies the reference levels due to its low duty cycle (0.029 %). For the (de)activators (measured for general public exposure i.e., at the client's side of the counter, thus separations for the averaging plane of more than 20 cm are possible for wider counters), H_{avg} does not exceed the reference levels.
Maximal values over the spatial grid (for distances from 20 cm on [2]) can be up to 148.0 A/m for the considered systems. The exposure ratios vary from 8 to 13 for EM, from 4 to 6 for AM, and from 0.008 to 1.8 for RF systems. We obtained as maximal values over the spatial grid 148.0 A/m for EM systems, 342.4 A/m for AM systems, and 0.14 A/m for RF systems. Safety distances are maximally 111 cm for EM, 77 cm for AM, and 35 cm for RF systems.

no. shop	gate/ activator	Freq.	mean (RMS A/m)	max (RMS A/m)
I. EM library	gate	230 Hz	127.32	148.01
	(de)act.	50 Hz	1.49	2.27
II. EM book shop	gate	485 Hz	91.29	108.23
	(de)act.	485 Hz	<0.10	<0.10
III. AM furniture	gate	58 kHz	25.80	42.40
	(de)act.	58 kHz	<0.02	<0.02
IV. AM music	gate	58 kHz	23.02	30.45
	(de)act.	-	-	-
V. RF supermarket	gate	8.2 MHz*	$563.9 \cdot 10^{-6}$	$705.5 \cdot 10^{-6}$
	(de)act.	-	-	-
VI. RF grocery	gate	9,1 MHz*	$0.108 \cdot 10^{-3}$	0,14
	(de)act.		<0.01	<0.01

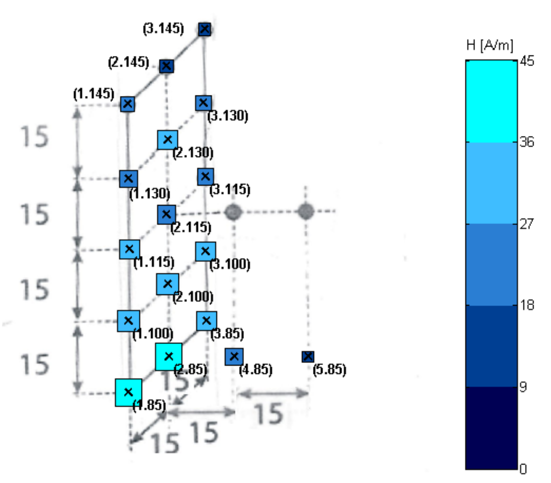

Figure 1: 3D figure of magnetic field values [A/m] at the measurement grid (AM system III).

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	(de)act.		<0.01	<0.01

Table 1: Considered EAS systems and magnetic fields.

CONCLUSIONS

Exposure of EAS systems are investigated in-situ for both the detection gate panels and the activators and deactivators. For the detection gates, the spatially averaged fields exceed the reference levels for 5 of the 6 investigated systems. For the (de)activators, the spatially averaged fields do not exceed the reference levels. Maximal fields up to 148.0 A/m are measured from 20 cm on. The exposure ratios vary from 8 to 13 for EM, from 6 to 8 for AM, and from 0.008 to 1.8 for RF systems. Safety distances are maximally 111 cm for EM, 77 cm for AM, and 35 cm for RF systems.

The exposures of the EAS systems exceed thus often the reference levels but compliance to the ICNIRP basic restrictions has to be checked. Further research is needed by executing measurements, which are very difficult in situ, or simulations (accurate model of EAS systems is required) of current density and specific absorption rate (SAR). Future research could also consist of performing more measurements in different countries, to increase the current set of in-situ exposure evaluations of EAS systems.

ACKNOWLEDGMENTS

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REFERENCES

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