

On a Survey of the Magnetic Field in a Commercial Area

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Abstract – In this paper we present the human exposure of low frequency magnetic field in a commercial area. To realize the study, we used two measurement instruments to obtain both spot measurements and the long term survey of the magnetic field. Referring to the spatial variability, we realised a map and graphical representations of the magnetic field at different heights, inside the commercial area. The magnetic field variability with height from the floor it was determined in two cases: when the equipments were connected or disconnected from the power supply network. The highest value of the magnetic field was identified near F1 freezer, when it is connected to the power supply network (1272 nT). Also, the maximum value of the magnetic field collected in the commercial area studied was under 2 μ T. Compared to the maximum values allowed by ICNIRP, this value is less than 2 %.

Keywords – human exposure, long term survey, magnetic field, spot measurements

I. INTRODUCTION

The human exposure to very low frequency magnetic field constituted an increased concern, so various studies are still being carried out. The long term human exposure at low frequency magnetic field [1] and the health and biological effects of the time-varying fields [2] is considered lately. In various studies [3], it was found that long-term exposure to the low frequency magnetic field, over 0.4 μ T, may be responsible for various pathological problems [4-5]. In our study we performed both spot measurements and a long term survey of a magnetic field [6-7] in a commercial area. Due to the fact that both commercial staff and the general public (adults and children) have access in this area, we have paid great attention to spatial and temporal variability of the magnetic field. In regard to the spatial variability, in the shop area we made a map of the magnetic field [8]. Also for the entire commercial area we made graphical representations of the magnetic field variability at different heights in two cases: when the equipments were

connected or disconnected from the power supply network. In the points where the values of the magnetic field are higher and both the general public and the staff have access, were made some automatic surveys of the magnetic field in different days.

II. DESCRIPTION OF THE METHOD

For determining the human exposure of magnetic field in a commercial area were realized both spot measurements and some automatic surveys of the magnetic field generated by the internal sources using two types of equipment. For both spot measurements and long term survey we used conventional equipment, the gauss meter PCE-G28 and an automated magnetic field measurement system realized in our laboratory [9-10]. In Fig. 1 is presented the map of the entire commercial space with all sources and the points where the measurements were made, namely the temporal and spatial variability study of the low frequency magnetic field.

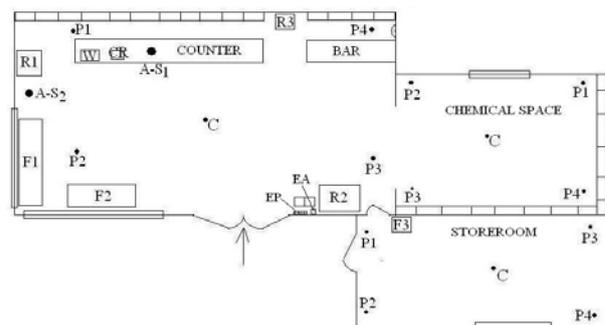


Fig. 1. Map of commercial area with the magnetic field sources and measurement points

The entire commercial space is divided into 3 sections: the shop, the chemical space and the storeroom. As magnetic field sources, we have identified three refrigerated showcases, **R1**, **R2**, **R3**, three freezers, **F1**, **F2**, **F3**, of which one, **F3**, is located in storeroom, an electric scale, **ES**, a cash register, **CR**, the electrical alarm, **EA**, the electric panel, **EP** and the power supply network. In the shop area, with the first instrument, we

made a map to get the spatial variability of the magnetic field. The strategic measurement points were selected at a high of 1 meter from the floor and at a distance of 0.5 meters between them. According to the number of equipments, their position and the magnetic field values from the spot measurements, we made automatic surveys in three strategic points with the second measurement instrument. The first point, **A-S₁** (Automatic-Survey 1), is located on the counter where both the seller and the customer have access, the second point, **A-S₂** (Automatic-Survey 2), is situated in front of a shelf between a freezer and a refrigerated showcase, and the last point is located near the F1 source, where the maximum values were found. Then, for the selected areas (the shop, the chemical room and storeroom), we determined the variability of the magnetic field with the height making measurements at three different heights from the floor (0, 1 and 2 meters). The values of the magnetic field, for these areas, were determined in two cases: when the equipments were connected (a) / disconnected (b) from the power supply network.

III. RESULTS AND DISCUSSIONS

As we mentioned before, in the shop area we made a map as is shown in Fig. 2. The highest values of the magnetic field identified in this area were near the first two freezers (F1, F2) and the first refrigerated showcase (R1). Also in the shop area were made measurement of magnetic field in five points: in the centre of the shop area, Centre, and in the points P1, P2, P3 and P4 from the shop area. The measurements were performed in two cases: when the equipments were connected or disconnected from the power supply network.

The highest values were recorded in P2 (271 nT) and P3 (222 nT) points because in this area are located F1 and F2 sources, respectively R2, as is shown in Fig. 3.

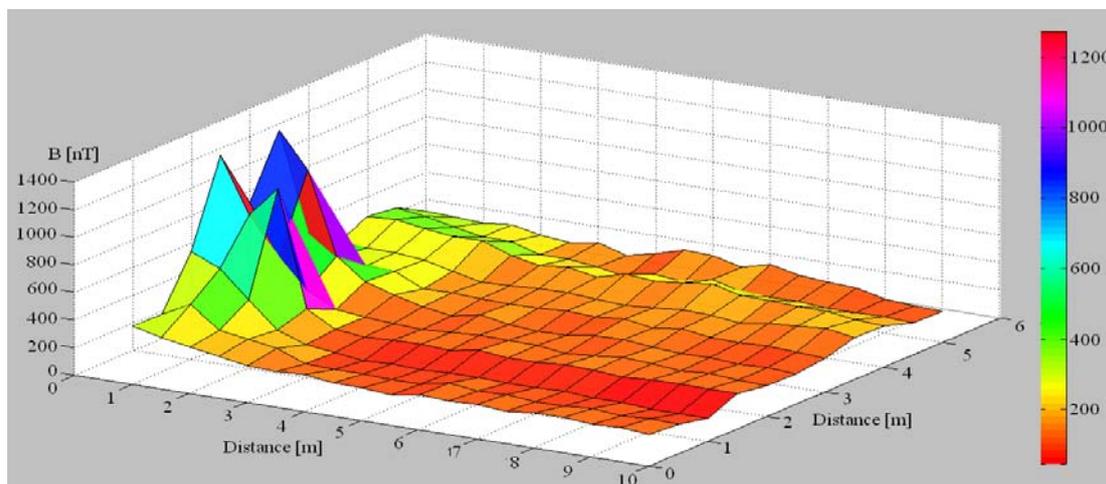


Fig. 2. The spatial variability of the magnetic field in the shop area

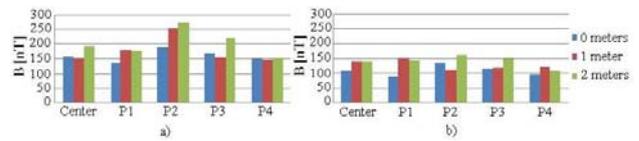


Fig. 3. The magnetic field measured in the shop area in some points at different heights with (a) and without (b) connected equipments

In the chemical space the measurements were made by the same method related to the shop area. The highest values were collected in **P3** (173 nT) and **P4** (166 nT) because these points are located beside **F3**, respectively near the general electric cable, as is shown in Fig. 4.

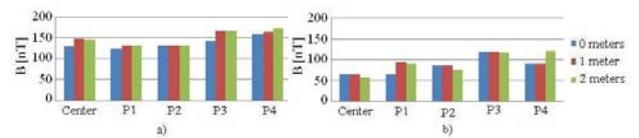


Fig. 4. The magnetic field collected in the chemical area in some points at different heights with (a) and without (b) connected equipments

In Fig. 5 we presented the magnetic field values identified in storeroom. The used method is the same like in the chemical space and the shop area. The maximum values were found in **P1** (260 nT) and **P3** (238 nT) because these points are located near the freezer **F3**, respectively near the general electric cable.

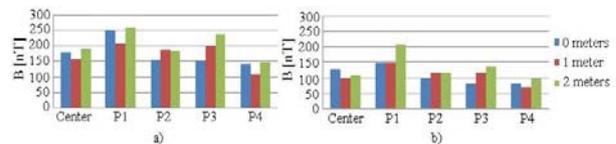


Fig. 5. The magnetic field identified in storeroom in some points at different heights with (a) and without (b) connected equipments

In Fig. 6 it is represented the time domain and frequency domain representation of the perpendicular components of magnetic field from **A-S₁** point. We made also, an automatic survey of background magnetic field for the entire program of work, as is shown in Fig. 7. The highest value in this area is 230 nT and the minimum values (96 nT) were collected at finishing the program of work because some equipments are disconnected from

the power supply network. Near F1 source we made an automatic survey of magnetic field at a height of 1 meter. We determinate the RMS values for 1 hour and 21 minutes, as are shown in Fig. 8. We can observe the start / stop moments of the equipments being equipped with thermostat. The highest value was identified at the beginning of the equipments operation, around the measuring point (1272 nT).

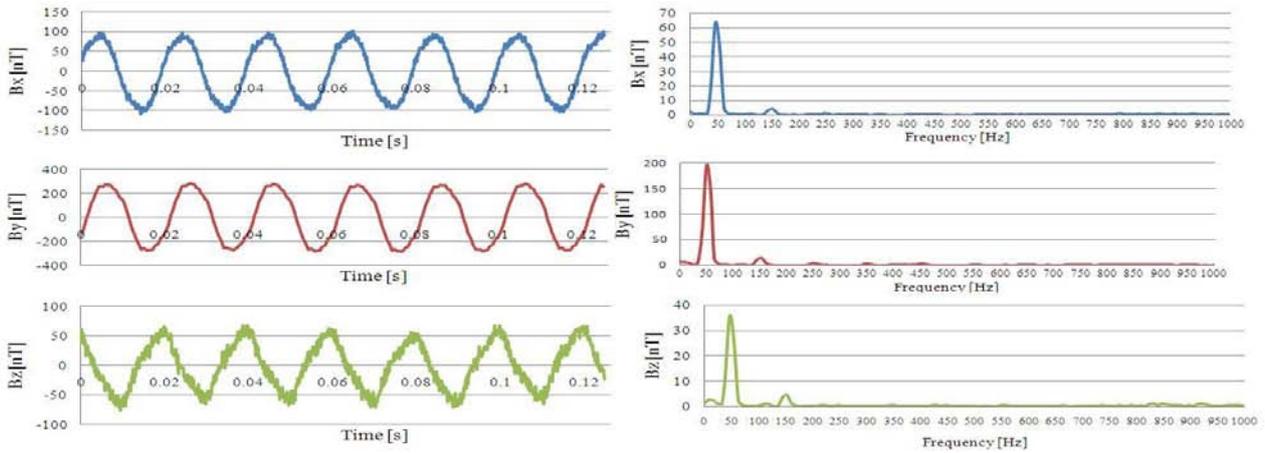


Fig. 6. Time domain and frequency domain representation for **A-S₁** point

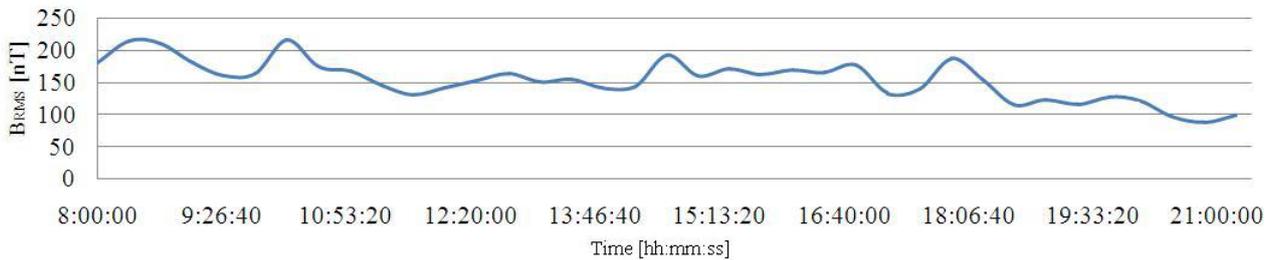


Fig. 7. Recording of B_{RMS} for 13 hours on **A-S₁** point (08.04.2017)

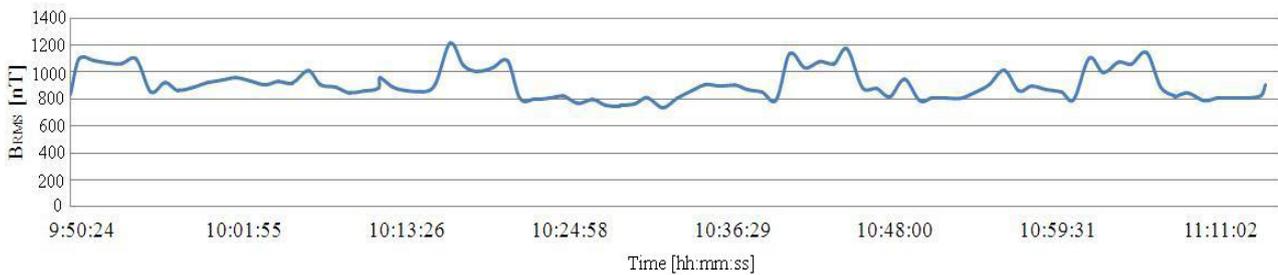


Fig. 8. Recording of B_{RMS} for 1 hour and 21 minutes near **F1** (15.04.2017)

For the A-S₂ point we made 24-hours of automatic long term survey in two Saturday from two consecutive weeks. We made this, to study the long term survey of the magnetic field in the area with the F1 and F2 sources. In

this area were identified a variation of magnetic field, between 258 ÷ 708 nT, as is shown in Fig. 9 and Fig. 10.

The values of the magnetic field in the two Saturdays are about the same with very low differences.

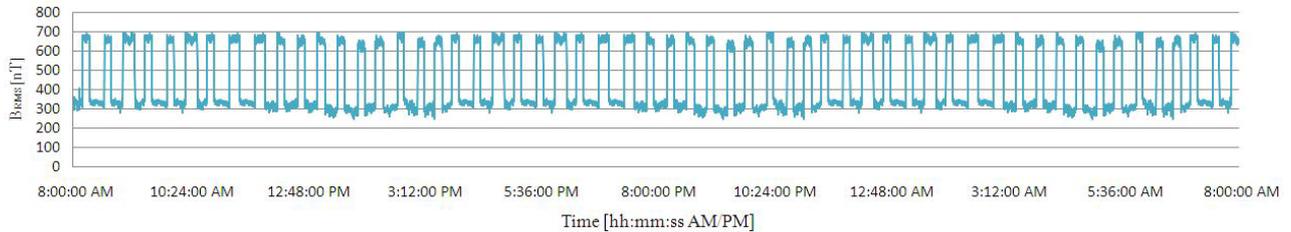


Fig. 9. Recording of B_{RMS} for 24 hours on A-S₂ point (08.07.2017)

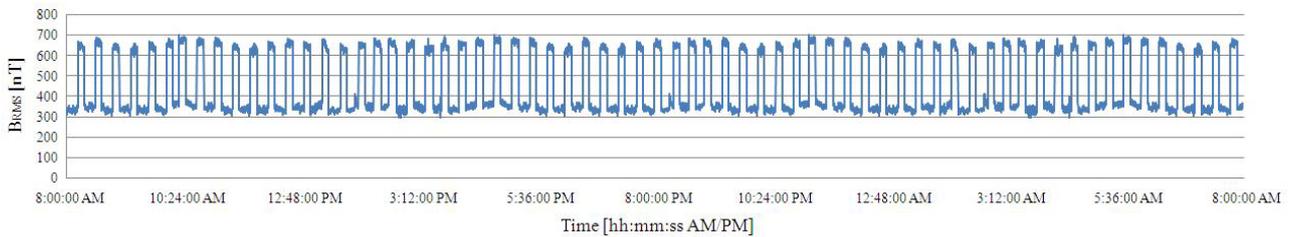


Fig. 10. Recording of B_{RMS} for 24 hours on A-S₂ point (15.07.2017)

Table 1. A statistical processing of data for 4 days of magnetic induction survey at different points in the shop.

Survey			Number of measurements	$B_{r.m.s.}$ [nT]				$\frac{t_{overaverage}}{t_{survey}} \cdot 100$ [%]
Zone	Period	Date		Min.	Average	Max.	Standard deviation	
A-S ₁	13 hours	08.04.2017	6686	96,21	154,21	230	42.67	49.13
Near F1	1 hour and 21 minutes	15.04.2017	695	787.08	965,36	1272	13.53	45.25
A-S ₂	24 hours	08.07.2017	12343	258,32	450,27	708	167.86	49.97
	24 hours	15.07.2017	12343	298,41	460,79	702	151.42	47.52

For a better analysis of the data we made a statistical processing of the RMS values from the three points where was made automated surveys of the magnetic field in the shop area in different periods. In Table 1 are shown: the measurement points, the long term survey period, the date of the survey, the number of measurements for each survey, the minimum, the

maximum and the average values of the magnetic field, the standard deviation and the time when the average values of the magnetic field was exceeded.

Finally we identified the B_{rms} Average and standard deviation for each area from the commercial space (the shop, the chemical space and the storeroom), presented in Table 2.

Table 2. The $B_{RMS\text{Average}}$ and Standard deviation of spatial variability of the magnetic field in the commercial space.

Zone	B_{rms} Average [nT]			Standard deviation [nT]		
	0 meters	1 meter	2 meters	0 meters	1 meter	2 meters
Shop	161.38	177.30	203.7	18.3	39.54	40.58
Chemical space	137.48	148.02	149.44	12.63	15.19	17.57
Storeroom	174.96	172.85	203.92	39.59	35.82	40.45

IV. CONCLUSIONS

In this study we made some measurements of low frequency magnetic field in a commercial area. The measurements were made by using two types of equipments: conventional equipment, gauss meter PCE – G28, and an automatic instrument, which allow both spot measurements and automatic long term survey with time domain and frequency domain representation.

We realized a map of the magnetic field inside the shop area and we observed a great spatial variability of the magnetic field (a ratio between maximum and minimal value is 1270 nT to 46 nT). The magnetic field variability with height from the floor it was determined in two cases: when the equipments were connected/disconnected from the power supply network. We found the highest values near the F1 source (1272 nT).

So, the maximum value obtained, of the magnetic field was under $2 \mu\text{T}$. Compared to the maximum values allowed by ICNIRP, this value is less than 2 %. Also, referring to the various studies on long-term human exposure to low frequency magnetic field, we have identified a few areas from the commercial space studied where the magnetic field value is greater than $0.4 \mu\text{T}$, which can be a concern in case of the children.

We observed that the highest values of magnetic field, were recorded near to the equipments with a lower energy class (R1, F1, F2), compared to the others, with a higher energy class (R2, R3 F3), where the magnetic field values were lower. Also, at determining the variability of the magnetic field with the height, the magnetic field values increased with increasing of the height, due to the fact that the electrical installation is made in the garret of the commercial area. Finally we made a statistical processing with significant values collected from the entire space.

V. ACKNOWLEDGMENT

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