ANALYSIS OF DISTRIBUTION, HIGH VOLTAGE AND TRAIN NETWORKS IN THE EXPERS STUDY

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ABSTRACT

The Health Ministry initiated a study on the personal exposure of the French population to 50 Hz magnetic field. One of the points of interest of this study is the contribution of each exposure source to the total exposure. We focus here on electric networks. The different data of the study, which includes a little more than 2000 subjects, allow us to identify for some subjects the presence of one or several networks close to home. The distance for taking such networks into account depends on the type of network: we considered all distribution and transmission networks, as well as electric train networks. From magnetic fields measurements, after we checked whether the identified networks are really influencing the exposure of subjects. The results depend on the type of network.

INTRODUCTION

The French Ministry of Health initiated a study of the personal exposure to 50 Hz magnetic field of the French population. The global results of this study, named EXPERS, are presented in another communication [1]. A point of interest is the contribution of each source of exposure to the total exposure. We focus here on electric networks.

MATERIALS AND METHODS

The MV2 Conseil survey institute collected for each subject:

- 24h magnetic field measurement
- timetable
- general questionnaire about home
- GPS coordinates
- address

For each type of electric network (low to very high voltage), we determined the maximum distance at which the magnetic field generated by the electric network remains theoretically measurable in a residence. This distance was calculated for overhead power lines of voltage 63kV and higher by simulating magnetic fields generated by the different types of networks, in the middle of the span and with the annual mean current. The distance kept is the one where the mean calculated magnetic field is less than 0.1 µT. The magnetic field depends also on the geometry of the line and the distance kept was the largest of the distances calculated for different geometries.
Note that for train networks, a distance of 200 m was arbitrarily chosen. The transport like metro or tramway were not taken into account.

All subjects within these corridors were arbitrarily classified as "exposed" to magnetic fields generated by electric networks. The address of the home was converted into Lambert II étendu coordinates (French Lambert coordinates) by RTE (the French electricity transmission network operator). The results of this calculation was validated by comparison to GPS coordinates measured.
The "exposed" subjects were identified from the addresses of subjects of EXPERS study by the network operators using their geographical data bases.

Corridor widths were defined as maximum distances, and therefore, some "exposed" residences are likely to be misclassified with regard to actual magnetic field exposure. This was analysed using the magnetic field exposure measurements of the volunteers living in these residences. Indeed, the variation over one day of the field generated by electric networks is quite characteristic, and a visual check generally allows to confirm or not the contribution of one (or several) electric lines to the magnetic field record.

Figure 1 gives the example of a subject where the source is a high voltage overhead power line. The characteristics are a signal with little noise and proportional to a load curve of a power line, i.e. maximum at the end of the day, decreasing during the night then increasing again in the morning.

Figure 2 gives an example representative of a subject where the source could be a middle voltage underground network. The signal presents the trend of a load curve during the night, but is noisy.

Figure 3 gives the example of a subject where the source is a train line. The characteristics are: a very noisy signal, proportional to traffic (maximum the evening and the morning, zero during the night), and with a ratio of harmonics above zero.

Signals are obviously not all as clear as in the examples given above. A lot are barely detectable and at the limit of ground noise. In order to privilege a conservative approach,

we noted as “really exposed” all subjects as soon as we noted a very low tendency at the limit of ground noise.

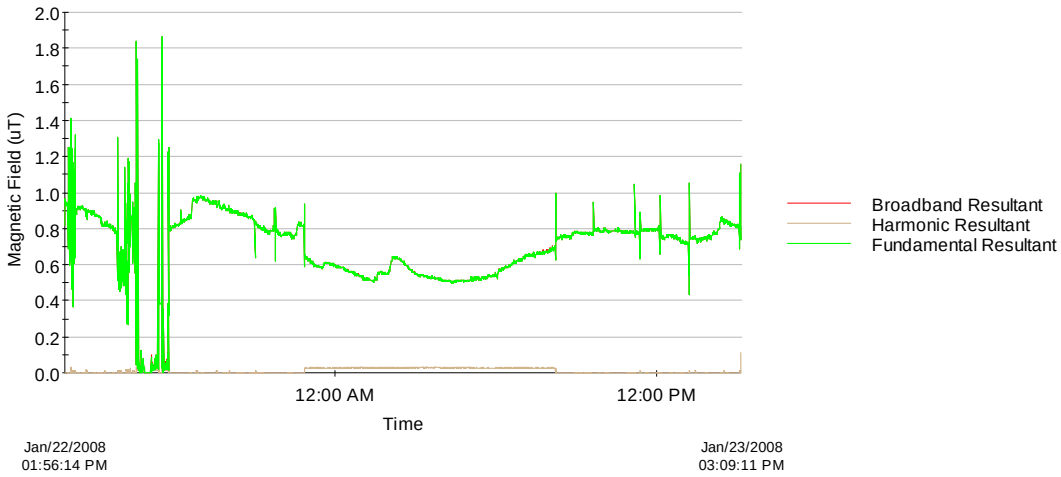

Figure 1: example of a subject really exposed to the magnetic field generated by a high voltage power line

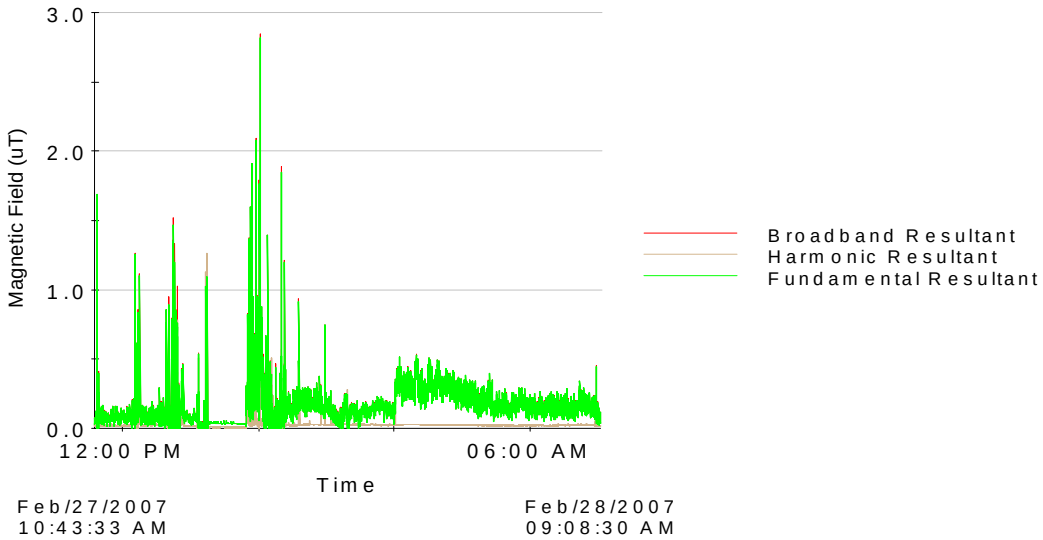

Figure 2: example of a subject really exposed to the magnetic field generated by a middle voltage power line

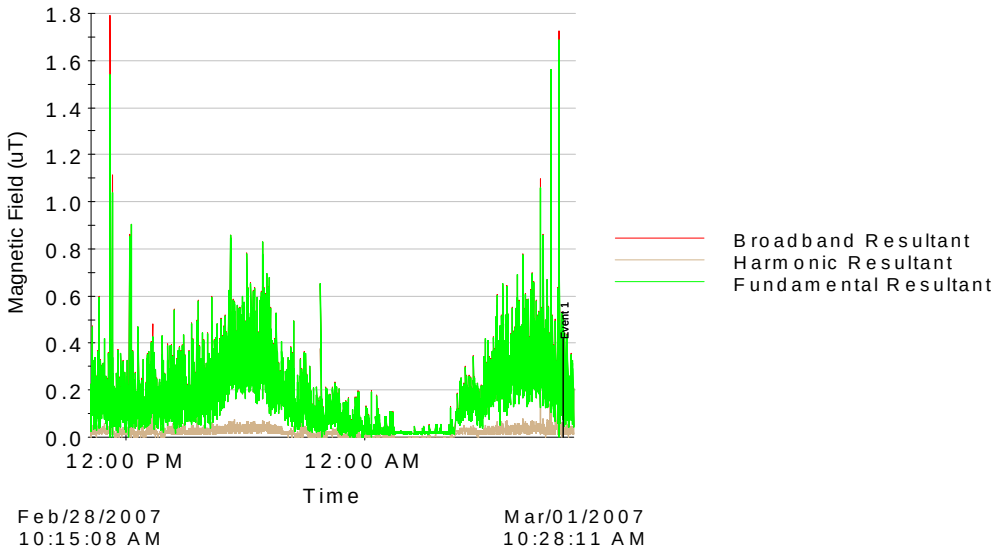

Figure 3: example of a subject really exposed to the magnetic field generated by a train line

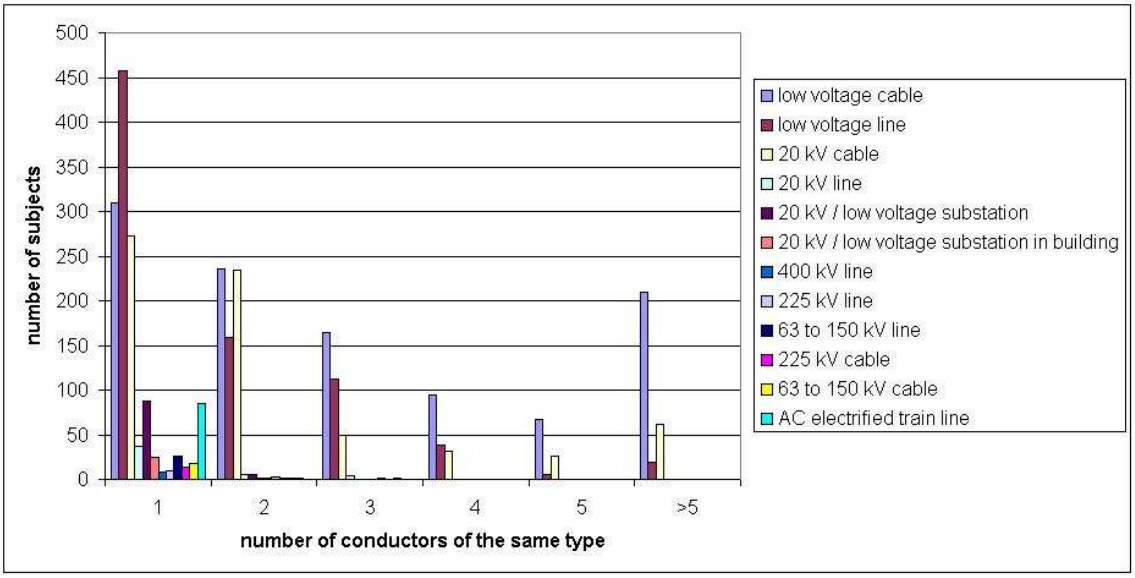

Figure 4 : repartition of subjects living close to electric networks

RESULTS

The EXPERS magnetic field database contains 2029 subjects (adults and children) and 1581 addresses. There are less addresses than subjects because an adult and a child of the same family could participate in the study.
Table 1 [1] gives the corridor width taken into account around electric networks, in function of the type of networks.
The position of RTE and ERDF networks is known with a precision of 10 m. For electric train networks, a distance of 200 m was chosen because of a lower precision on the position of networks, determined from IGN(Institut Géographique National) data, with a precision around 100 m. For low and middle voltage networks, a distance of 20 m was chosen.

The number of « exposed » subjects varies between 9 for 400 kV lines (table 2), 85 for train lines (table 3) to 1081 for low voltage underground lines (table 4).

	Number of subjects
Overhead line 20 kV	46
Overhead low voltage line	792
Underground line 20 kV	674
Underground low voltage line	1081
MV/LV substation	94
From which MV/LV substation in building	26

Table 1. Distribution of subjects « exposed » to magnetic field generated by ERDF networks

	Number of subjects	**remarks**
Overhead line 400 kV	9	8 subjects « exposed » to several power overhead lines (of the same type or not)
Overhead line 225 kV	13	
Overhead line 63 to 150 kV	27	
Underground line 225 kV	17	5 subjects « exposed » to several lines
Underground line 63 to 150 kV	20	

Table 2. Distribution of subjects « exposed » to magnetic field generated by RTE networks

	Number of subjects	**remarks**
Train line	85	40 subjects are in Ile-de-France (Paris region)

Table 3. Distribution of subjects « exposed » to magnetic field generated by AC electrified train line

Figure 4 shows that most of subjects living close to power networks are close to only one conductor, when a significant part of those living close to distribution networks are close to several conductor of the same type.

The visual analysis of measurements for all “exposed”

subjects (table 5) shows that the magnetic field generated by the networks was detected in a proportion varying from 85 % of subjects "exposed" to magnetic field generated by very high voltage overhead power lines to 30 % of subjects "exposed" to magnetic field generated by AC electrified train lines and less than 10 % of subjects "exposed" to magnetic field generated by 20kV overhead lines.

	Number of subjects	**Measurements with influence of an electric network**
Overhead line 400 kV	9	8
Overhead line 225 kV	13	11
Overhead line 63 to 150 kV	27	6
Underground line 225 kV	17	6
Underground line 63 to 150 kV	20	8
Train line	85	25
Overhead line 20 kV	46	2
Low voltage overhead line	792	106
Underground line 20 kV	674	131
Low voltage underground line	1081	157
MV/LV substation	94	16
From which MV/LV substation in building	26	4

Table 4. Analysis of the magnetic field measurements for subjects « exposed » to magnetic field generated by electric networks

DISCUSSION

Among the subjects living close to an electric network, we have identified those whose measurements show the influence of an electric network. But this does not mean always that the electric network source is the one identified. As an example, we have been able to compare the magnetic field measurements with the recordings of current in the 63 kV to 400 kV overhead power lines. The curves did not always correspond, especially for 63 to 150 kV lines. This difference illustrates the fact that the magnetic field measured is the summation of all magnetic field emitted by all sources: overhead power line are not the only sources influencing the exposure at home.

The substations in buildings are one of the point of interest of the magnetic field sources of the distribution network. In our study we have 26 subjects living within 20m around a substation in building. Only 4 have an exposure which can be explained by an electric network that could be a substation, but in fact the number of subject that are really exposed to the magnetic field from a substation in buiding is smaller. The subject has to live just beside or above the substation. We are looking more precisely at the position of the substation and the floor of the apartment: the number of subject really exposed at magnetic field emitted by a substation in building goes from 0 to 2.

The assessment of magnetic field exposure is a crucial point in epidemiological studies. This is usually done by measurement or calculations, but also by use of distance to power lines criteria. Some authors have already criticize the use of distance to power line as indicator of residential exposure to magnetic field [2]. Our results are in agreement, and moreover show that power lines are not a significant source of exposure in the French population.

CONCLUSION

This papers shows that:

- stating from a random sample of the French population, the number of subjects living in the vicinity of high voltage power lines is small,
- defining "exposure corridors" on the single criteria of distance, can lead to misclassification of residences, particularly for lower voltages. It should also be noted that, in many cases, the magnetic field "detected" on measurements was very low, just above the background level (< 0,1 µT).

This work will continue with improvement of analysis of distribution network data.

Acknowledgments

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