

Reduction of the public exposure due to cellular network base stations while maintaining the coverage and the quality of service

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This paper presents the results of two recent studies by the French administration regarding public exposure to radiofrequency electromagnetic fields. The first study discusses reducing public exposure from cellular network base stations while maintaining the coverage and the quality of service. The second one summarizes the update of the expert appraisal on health aspects.

1) Reducing public exposure due to cellular network base stations while maintaining the quality of service

Context of the experiments

Following the conclusions of a national Conference on the Environment organized by the French government for making long term environmental decisions, a technical comity was created in July 2009.

This comity involved around thirty stakeholders: consumer associations, environmental organizations, telecom equipment manufacturers, mobile network operators, experts, associations of locally elected representatives and public administrations (Environment Ministry, Industry Ministry, Spectrum Management Agency). It particularly studied the feasibility of lowering the exposure to electromagnetic fields emitted by mobile network base stations while maintaining the quality of service.

For four years, a significant level of expertise was mobilized, as well as sixteen towns chosen for carrying out modelling and measurement experimentations, illustrating the diversity of the environment in France.

A French report was published by ministries (Ministère de l'écologie, du développement durable et de l'énergie and ministère du redressement productif) in July 2014 and this paper summarizes the results (<http://www.redressement-productif.gouv.fr/antennes-relais-telephonie-mobile-conclusions-des-experimentations-sur-lexposition-et-concertation-remises-aux-mini>).

Modelling highlights the overall low level of public exposure to electromagnetic fields emitted by mobile network base stations

In 2010 and 2011 an inventory in the 16 selected town areas was initially lead and used as a reference for the following of the studies. It included modelling and measurements of exposure, coverage and quality of service. This inventory takes into account 2G and 3G networks which were open to the public by the end of 2012 but not the 4G one.

Modelling was achieved for more than three hundreds of millions of points for every front of building and surface area. The modelling exposure is theoretical and maximized: it is based on the hypothesis that all the transmitters emit at the same time and at the maximum power.

Including all the areas, the inventory shows that about 90% of the levels of exposure are below 0.7 V/m and 99 % below 2.7 V/m whereas the regulatory limits stand between 40 V/m and 61 V/m for the mobile networks. The main results are summarized in the following table.

	50%	90%	99%	100% (Max)
Rural low relief	0.03 V/m	0.2 V/m	0.5 V/m	5.1 V/m
Rural mountainous area	0.1 V/m	0.7 V/m	2.2 V/m	6.5 V/m
Peri-urban sparsely populated	0.1 V/m	0.4 V/m	1.2 V/m	6.5 V/m
Modern urban densely populated	0.2 V/m	2.4 V/m	3.0 V/m	27.7 V/m
Ancient city centre densely populated	0.2 V/m	1.0 V/m	2.3 V/m	30.5 V/m
High densely populated	0.2 V/m	1.0 V/m	2.4 V/m	15.4 V/m
Total	0.1 V/m	0.7 V/m	2.7 V/m	30.5 V/m

The table reads as follows: for example, 99% of levels of exposure in towns with a peri-urban environment sparsely populated are below 1.2 V/m.

Lessons learned from exposure measurements

In each experimental town area, different types of measurements were achieved in around 10 spots chosen in living spaces or area open to the public and identified from the modelling as the most exposed in comparison with the rest of the neighboring area. These geographically isolated spots called « Most exposed spots » are characterized by an exposure significantly higher than the average in the area.

Measurements in the most exposed places have shown that in around 20 % of cases, mobile network base stations are not the main source of exposure. The other sources are particularly: DECT, FM transmitters, mobile phone in the vicinity, Wi-Fi....

In addition, whereas the most exposed spot is twice or three time higher than the average exposure in the other rooms of the same living space underlining a strong spatial variability of exposure, there is a low variation of the exposure linked with the traffic of mobile network base stations present during the trials (2G and 3G). The amplitude of variation of the level of exposure (RMS value over 6 minutes) is generally less than 30 % which remains under the uncertainty of measurement.

Processing of the Most Exposed Spots

128 Most Exposed spots were identified during the inventory. Levels of exposure vary between values below 0.3 V/m and up to 10 V/m taking into account the processing of extrapolation at the maximum power of the transmitters.

Among these spots, seven have been selected due to their level of exposure among the highest ones to simulate slight engineering modifications (tilt, azimuth, height) or localization in order to reduce their exposure. One was actually processed in Paris.

Simulations show that a reduction of exposure is possible without significant degradation of the coverage. It is appropriate to be especially vigilant in order to avoid a too important redistribution of the exposure for other spots localized in the vicinity.

This type of processing constitutes one of the components of reduction of the exposure. It can also be achieved through a global reduction of the antenna powers.

Consequences on coverage and quality of service of a global reduction of the exposure

Simulations to reduce the exposure in different areas were achieved for 2G and 3G networks.

These simulations done at the maximum power of the transmitters and backed up by trials have shown that a reduction of the exposure for every front of building and surface area at 0.6 V/m involves a sharp deterioration of network coverage (and thus of the quality of mobile network service), especially inside buildings (for example an average loss of 82 % for the indoor coverage in Paris 14th district)

A need to increase the number of antennas to combine low exposure and sufficient coverage

Simulations of reconfiguration of the antenna network have been achieved for seven towns illustrating the various urban typologies in France. It consisted in adding new sites to restore the initial coverage while maintaining a level of exposure below 0.6 V/m. The conclusion is that the number of sites should be multiplied by at least three.

The results of the reconfigurations has to be considered as a minimum since the modelling does not take into account several essential parameters (volume of communication, degradation of quality of service, flow of traffic, accessibility of sites).

LTE deployment should be accompanied by an increase in public exposure

LTE has been taken into account by simulations based in principle on majoring assumptions (63 dBm PIRE for each transmitter). The result of the simulation is an increase of the exposure of around 50 %. For example, on the ground in a Paris district area, the average exposure would increase approximately from 0.6 V/m to 0.9 V/m.

On top of the simulations, a measurements campaign was carried out in a French town with a real LTE deployment (before and after LTE was switched on). The results indicate an average increase of the exposure of about 15% to 20%. These figures better represents the actual increase in exposition due to LTE.

2) Update of the expert appraisal on the health aspects

In June 2011, the French Agency for Food, Environmental and Occupational Health & Safety (ANSES) issued an internal request for an update of the “Radiofrequencies and health” expert appraisal published by the Agency in October 2009 (http://www.anses.fr/sites/default/files/documents/AP2011sa0150RaEN_1.pdf). Since 2009 and in the context of wireless technology applications using RF fields which are constantly changing, numerous scientific papers have been published (more than 1 000 publications have been identified) and the international Agency for research on cancer (IARC) classified RF electromagnetic fields as “Possibly carcinogenic to humans” (2B) for brain tumours.

The scope of the update was to evaluate the level of evidence for:

- Central nervous system effects: cognitive functions, sleep, *etc.*
- No carcinogenic effects (besides central nervous system): reproduction, *etc.*
- Carcinogenic effects: brain tumours, leukaemia, *etc.*

For each effect analyzed, data supporting the existence of the effect taken from studies using biological models (in vivo animal or in vitro studies), and data from clinical or epidemiological studies were classified as: “sufficient”, “limited” or “inadequate”, or alternatively “suggesting a lack of effect”.

All the studies (except one) showing effects have been carried out with exposure levels similar to those of the mobile phone.

Biological and physiological effects have been observed under certain conditions.

As in 2009, apoptosis and oxidative stress effects have been confirmed. On the contrary, observed effects in 2009 on the cerebral blood flow do not look confirmed.

New physiological effects have been highlighted:

- short term effect on cerebral electrical effect (for human)
- Increase of number of periods of REM sleep (for animal)

It is not possible today to establish a link between these biological or physiological effects, a mechanism of action and health effects which would result.

Certain effects have been highlighted with limited evidence data:

- cognitive performances , memory and fertility (for animal)
- cerebral electric activity (for human)

Health effects look possible: glioma and acoustic neurinoma, but with a low risk.

Until now, most of the effects appear to be transient or involve basic biological variation, demonstrating the ability of biological systems to repair or restore homeostasis. It is therefore impossible to conclude that the observed biological effects have effects on health.

The conclusion of ANSES to the French government is that current exposure limits do not have to be reduced, as far as health preservation is concerned.