GENERAL PUBLIC EXPOSURE TO RADIOFREQUENCY ELECTROMAGNETIC FIELDS GENERATED BY MOBILE COMMUNICATIONS JAMMERS.

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Abstract - **In recent years the communication services have seen a rapid progress and development, creating new scenarios of exposure to non-ionizing radiation (NIR). Due the preoccupation concerning the potential effects of the NIR arise.**

This paper approaches the study of a new emerging scenario given by exposure to NIR generated by mobile communications jammers in order to know the possible exposure levels, compared with the current limits and the levels in other studied scenarios.

Such devices are installed in banks, offices and financial entities for safety reasons.

Resumen – **Los servicios de radiocomunicación han registrado un vertiginoso avance y desarrollo en los últimos tiempos, creándose nuevos escenarios de exposición a las radiaciones no ionizantes (RNI). A raíz de esto surge la preocupación referente a los eventuales efectos de dichas radiaciones.**

El presente trabajo aborda el estudio de un nuevo escenario emergente dado por la exposición a las RNI generadas por inhibidores de comunicaciones móviles a fin de conocer los posibles valores de exposición, comparándolos con los límites vigentes y los niveles existentes en otros escenarios estudiados.

Dichos dispositivos son instalados en bancos, oficinas y entidades financieras por razones de seguridad.

Keywords – **jammer, non-ionizing radiation, exposure levels, exposure limits, mobile communications.**

1. INTRODUCTION

The radio and TV broadcasting services have existed for latest 70 and 50 years respectively. Today, information transmission via global telecommunication networks characterized a new era in which the human being is the beneficiary and protagonist of sustained growth of wireless telecommunications services (mobile telephony, mobile broadband, Internet ...) [1]. Among them, mobile phone is one of the services has been a worldwide significant and rapid development, and Latin America has not been the exception [2].

Due to this, are citizens concern regarding the potential adverse health effects that may be associated with exposure to non-ionizing radiation (NIR) in the radio frequency spectrum (RF) used by those applications and, therefore governments (national, provincial, local) need to implement risk management programs that include risk assessment as systematic activity.

Previously to this evaluation, it is necessary to characterize the risk and for this purpose, should assess the amount of exposure (or potential exposure) of persons to NIR in real situations [3] [4]. In other words, without this information the governments are unable to incorporate effective strategies and actions [5] [6] [7] to their risk management programs, due to the absence of information about potentially dangerous situation.

Simultaneously, the experience (acquired from the implantation of mobile phones) has shown that, once new technology is implemented, the speed of adoption can be increased very quickly. Therefore, the World Health Organization determined that the exploration of exposure scenarios and their corresponding levels of electromagnetic field are high priority research topics, both the new and emerging technologies included in RF range of 100 kHz to 300 GHz and changes in the use of established technologies [8].

Consequently, the search for new scenarios and the data obtention about exposure levels existing in them, remain critical for people and government because it make possible to develop methods of exposure assessment and formulate appropriate hypotheses to frame the design of future epidemiological investigations. At the same time, provide sufficient information to improve public acceptance of scientific assessments of health risk and make balanced decisions on health and safety. Evaluations of general public exposure levels to NIR conducted both in Europe [9] [10] [11] and South America [12] [13] [14], are numerous, while in the latter region, there are also developments of new measurement methods [15]. However, the majority provides information on measured levels in scenarios already known, for example, open space and around the sources as broadcast antennas or mobile phone base stations.

Although results are related to new forms of wireless communications (Wi-Fi [16], Bluetooth [17], and UMTS [18]) and other RF sources different from those associated with wireless telecommunications [19], they can be considered insufficient to represent the diversity of scenarios to investigate [20]. As a result, the Laboratorio de Investigación Aplicada y Desarrollo (LIADE) within the Departamento de Electrónica, Facultad de Ciencias Exactas, Físicas y Naturales of the Universidad Nacional de Córdoba, conducted explorations of new scenarios to be evaluated and identified mobile communication jammers as a new emerging technology that deserves study.

These devices are made up low-power transmitters which broadcast in the bands assigned to mobile communications, in order to raise the noise level to prevent a communication can be established with mobile phones within a certain radius.

Its use is common in places where inhibition of communications is necessary for security or confidentiality reasons, such as banks and financial institutions, offices, prisons, etc; this activity in some cases was regulated [21] [22].

This paper shows the results of a survey of a cellular jammer device located in four typical different installations and compares the measured values with the exposure levels found in other scenarios and exposure internationally recommended limits.

2. MATERIALS AND METHODS

2.1. EXPLORATION OF SCENARIO

The frequency bands in which they devices operate so those which are assigned to the wireless communications services and work by increasing the noise level of the band making the communications impossible.

The equipment has an omnidirectional antenna for broadcast band.

Inhibitors are usually installed in the roof usually above the ceiling may have a range of up to 50 meters. The antennas are in this case horizontally. In the case of installation on a wall the antennas remain vertically.

Some user manuals specify to place a reflective material (metal sheet) on the place of installation of the equipment in case that top floor is inhabited.

2.2. EQUIPMENT AND INSTALATION.

For this study a four band jammer was used (800, 900, 1800 and 1900MHz) of 35dBm at 900MHz and 800MHz bands 34dBm in upper bands, according to specifications. The device was placed at a height of 2.6m between roof and ceiling. The measurement was made with the antennas in horizontal and vertical position and with and without reflective sheet (60cm x 40cm x 1mm metal sheet) over equipment in order to cover all possible installation conditions.

2.3. MEASUREMENT INSTRUMENTS

To measure the exposure levels in the evaluated scenario three systems of measurement [23] were used:

- Wandel & Goltermann instrument; model EMR-300 with E-field probe Wandel & Goltermann; model E-Field type 8.
- Narda instrument; model EMR-300 with E-field probe Narda; model E-Field type 18.0.
- Narda instrument; model NBM-550 with E-Field probe Narda; model EF-0391.

Each mentioned system consists of a portable analyzers, which have a frequency bandwidth coverage of 100 kHz to 3 GHz, high sensitivity (0.00001 mW/cm^2), and equipped with a three axes isotropic probe suitable for electrical field measuring according to the requirements of the IEEE standard C95.3 [24]. The three systems are calibrated to ensure measurement traceability to international reference standards (Physikalisch-Technische Bundesanstalt, PTB-Germany) and have a maximum calibration uncertainty of 1.5 dB, which is less than 2 dB advised by ICNIRP [25].

The described systems calculate the power density (S) of the signal from the electric field measurement (integration of the three axes of the probe) by applying the Fast Fourier Transform, then, store the results to be exported to a computer.

2.4. MEASUREMENT PROCEDURE

After the device was installed, measurements were made both downstairs and upper floor, over its longitudinal axis at different distances from the device (0m, 1m, 2m, 3m and 5m). At each distance five measurements were performed at different heights, 0.4m, 0.8m, 1.2m, 1.6m and 2m height on each floor. The measurements are repeated rotating the device 90º. The arrangement of the measuring points is shown in Fig. 1.

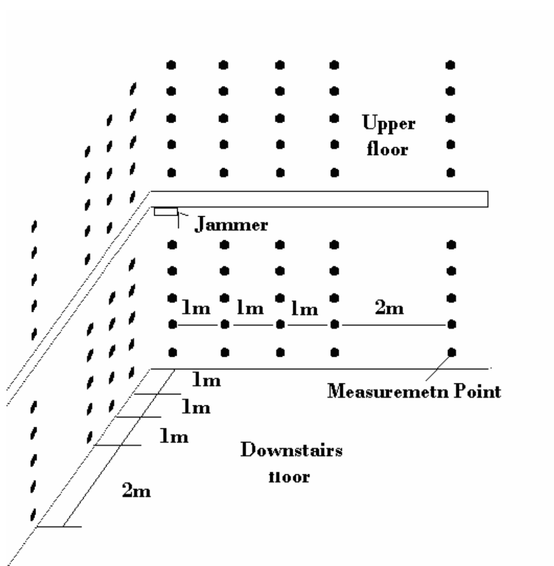

Fig.1. Measurement points.

These points were repeated for the four installation configurations.

The configuration 1: no reflector and horizontal antenna, 2: with reflector and horizontal antenna, 3: no reflector and vertical antenna and 4: with reflector and vertical antenna.

All measurements were performed in wideband (range 100 kHz - 3 GHz).

At each point, 6 minutes data logging was preformed and time average is calculated. The result of this operation is a value of electromagnetic power density **S** [mW/cm^2] which represents the average of all the instantaneous power density values sampled in the time interval mentioned.

Due to the large number of sampling points the three instruments were used simultaneously.

2.5. DATA

During the work, corresponding to 4 scenarios a total of 340 points equivalent to 34 hours of data registry was analyzed.

The power density values **S** expressed in mW/cm2, obtained as a result of each measurement point, the general average (average of all **S** values) and the higher value (higher **S** value) are compared with the security levels set by the regulatory in Argentina, compatible with standards recommended by ICNIRP reference levels [26], and additionally exposure levels measured in other scenarios evaluated by the laboratory.

Although described measurements were performed with broadband equipment, the values can be assumed to correspond to the bands of interest since the base level recorded with the inhibitor off is two orders of magnitude below the lower results obtained.

As stated in the previous paragraph the values obtained can be compared with the exposure limits for 850MHz.

3. RESULTS

3.1. SCENARIO RESULTS

The general average value, the general average value for each installation configuration and the highest value founded are shown in Table 1.

Table 1. Measured values.

	[mW/cm^2]	%
Average General	0,0189	4,5
Average Configuration 1	0,0210	4,9
Average Configuration 2	0,0185	4,3
Average Configuration 3	0,0171	4,0
Average Configuration 4	0,0192	4,5
Higher measurement	0,1612	37,9

The percentage values corresponding to the comparison with the limit 0.425 mW/cm^2, limit for the lowest band used in mobile communications. However to determine compliance of an installation according to current legislation in Argentina with broadband instruments, the comparison should be with the more restrictive limit, which is 0.2 mW/cm^2 [27]. In the latter case the higher value corresponds to 80.6% of the reference value.

Although there is an increase of the values registered in the upper floor without the reflector assemblies located on the jammer device, as shown in Table 2 these variations are not significant.

Table 2. Reflector influence.

	[mW/cm^2]	%
Average with reflector	0,0188	4,4
Max. with reflector	0,1413	33,2
Average without reflector	0,0191	4,5
Max. without reflector	0,1612	37,9

3.2. COMPARISON

Similar to this work the analysis to exposure to NIR exposure of different scenarios had been performed previously by LIADE [28]. A comparison of the exposure values caused by different sources is shown below.

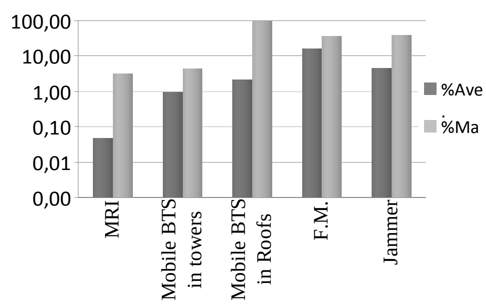

Fig.1. Comparison with other scenarios.

Table 3 . Comparison with other scenarios

%	MRI	Mobile BTS in Towers	Mobile BTS in Roofs	FM	Jammer
Average.	0,05	0,96	2,08	16,0	4,46
Máx.	3,06	4,35	93,2	35,0	37,93

Table 1 shown values for different scenarios surveys previously conducted.

For the purposes of this study, the percentage values correspond to the ratio of the values obtained with the limits for the frequency band used in the service that is 0.2 mW/cm^2 for magnetic resonance imaging equipment and FM broadcasting, and 0.425 mW/cm^2 for mobile telephony either the base station was installed in a tower or on the building roof .

It can be seen that although the studied scenario were not detected points above the limit value, is one of the scenarios with higher exposure values.

4. CONCLUSIONS

This study is based on analysis of an installation preformed for the purpose of this work, while the results obtained for other scenarios arise from statistical analysis of measurements tens or thousands (in the case of base station towers) installations.

It is therefore advisable to carry out further work with surveys of this type of facilities to obtain statistically significant results.

It is one of the scenarios studied with higher values. As can be seen the values found are comparable in magnitude to the values recorded near BTS antennas installed on roofs or FM towers

Although there were no values exceeding the recommended limits, the values obtained are close to them (37.93% of the limit for the 800MHz band and 80.6% of the most restrictive limit, used to determine compliance with broadband measurements). For this may be considered of interest the systematic study of this scenario in order to determine compliance of each installation.

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