METHODOLOGY OF MEASUREMENTS AND EVALUATIONS OF ELECTROMAGNETIC FIELDS AROUND RADIOTRANSMITTER DEVICES

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Abstract

The radiotransmitter devices are densely widespread in all the national territory, and their increasing use poses serious problems of exposure evaluation, both for the professional exposed people, and for the public. This problem is of some concern, owing to the many interrelated factors, which must be taken into account, during the measurements. In this work the authors show a procedure to evaluate the electromagnetic fields, generated by radiotransmission antennas in the frequency range of medium and short waves. The developed methodology represents a result of a great number of measurements and of many monitoring programs, which have included a wide number of different measuring points around the sources, different environmental conditions and various measurement systems. Moreover the measurements have been made in many different hours of the day, because the transmission systems (frequency and power transmission) are many and different during the day.

Source Characteristics

The monitored sources are the radiotransmitter devices in AM of the National broadcasting network (RAI), placed in Rome, and their characteristics are:

- Short Waves Centre

In this centre there are 45 antennas with 60 transmission systems. The radiation frequency of all the transmission plants (5) changes during the 24 hours. Its value goes from a minimum of 6 MHz up to a maximum of 21.69 MHz.

- Medium Waves Centre

The plant is constitued by two antennas with the following characteristics:

1) f = 846 kHz, P_{out} = 540 kW
   This is a two dipoles antenna in $\lambda/2$, and every dipole is fed by a 240 kW peak power. The transmission pattern is perpendicular to the dipole connection line. The system gain gives a 1700 kW power in the maximum propagation situation.
2) f = 1332 kHz, P_{out} = 300 kW
   This is a three dipoles antenna in $\lambda/2$. The dipoles are fed

with currents reciprocally 120° out of phase. The system gain gives a 1248 kW radiating power in the maximum propagation situation.

Measurement Methodology

Owing to the wavelengths of interest in the radiotransmitter range of medium and short waves, the monitoring surveillance program must involve, for the evaluation of the potential hazardous agent, the measurement of the electric and magnetic field strenghts in the near field region, and of the power density in the far field region. In fact in both the regions there are exposed people. By source characteristic examination, the most significant points, from a protection point of view, have been located. These points have been selected in relation to:

i) effective workplace of operators;
ii) theoretic evaluation of exposure level;
iii) possibility to find high field strengths level, owing to the presence of interference on the radiation pattern.

In addition selected points occupied by the general public and in the nearby vicinity of the radiotransmitter plants have been monitored, for the purpose to evaluate the public exposure. The measurements have been made using different broadband systems, able to detect and evaluate the field strengths in the frequency range of interest. All the data have been carried out taking into account the worst exposure conditions, and have been detected in different hours of the day, in respect of the different transmission systems. The set up methodology proceeds as follows:

1) the measurement instruments should be placed on a non conducting tripod;
2) the measurements should be made keeping a distance of at least 50 cm from the instrument;
3) the measurements should be made starting from the maximum safety distance and gradually diminishing it, with the purpose to avoid uncontrolled surveillance people exposure and damages to the probe;
4) the exposure level mean values should be determined in the previously established points (see i), ii), iii)), at a distance from the ground of about 1 m and 1.50 m (target organs) and at different times in the day;
5) the measurement points should be selected as follows:
   - at a distance of about 1 m from any possible fixed and/or mobile obstacle;
   - at very close proximity to re-irradiating points (e.g. telephone wires, electrical conducters, etc.) for the purpose of detecting "hot spots".

It is very important to select monitoring points, so that further measurements may be undertaken if and when required.

Table 1 shows an example of detected values for every selected measurement point. The measured values are after reported on the graph, and Graph 1 is an example of this one, and shows the electric field strength at the different hours of the day.

Conclusions

On the basis of the great amount of evaluations - more than 6,000 - the following recommendations may be utilized:

1) make the measurements at least along three directions, in order to detect the eventual preferential irradiating stream, even if isotropic probes are used;
2) correct the detected values due to:

- different measurement instruments;
- signal characteristics;
- exposure conditions.

In addition, in order to protect the exposed people against the possible presence of "hot spots" and to avoid high level of field strengths in the nearby of great conductor body, it is necessary:

1) earth the metal conductor, telephone wires, radiators, etc.;
2) earth water and gas mains, and waste pipes.

T A B L E 1

ELECTRIC FIELD STRENGHTS (V/m)

hour	day: n			day: n + 1			day: n + 2			mean
	$\bar{n}_1$	$\bar{n}_2$	$\bar{n}_3$	$\bar{n}_4$	$\bar{n}_5$	$\bar{n}_6$	$\bar{n}_7$	$\bar{n}_8$	$\bar{n}_9$	$\sum \bar{n}_i / N$
a.m.										
00.00	105	98	90	100	100	132	118	100	100	104.7
00.30	100	98	90	110	94	100	105	120	100	101.8
01.00	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::::
:::::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::::
:::::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::::
04.00	110	115	120	100	116	110	105	100	120	110.6
05.00	62	64	68	69	54	54	54	69	66	62.0
:::::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::::
10.30	60	55	67	61	59	65	65	58	60	60.0
11.30	61	59	67	63	55	64	58	61	61	61.0
12.00	100	98	92	86	89	96	98	105	115	97.6
p.m.										
12.30	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::::
:::::	:::	:::	:::	:::	:::	:::	:::	:::	:::	:::::
04.00	60	57	55	61	59	65	65	60	58	60.0
04.30	97	96	84	90	86	91	93	98	109	93,7
:::::	:::	:::	:::	:::	:::	:::	:::	:::	::::	:::::
09.00	100	98	92	86	89	96	98	105	115	97.6
:::::	:::	:::	:::	:::	:::	:::	:::	:::	::::	:::::
11.30	110	116	100	120	109	110	115	105	110	105.0

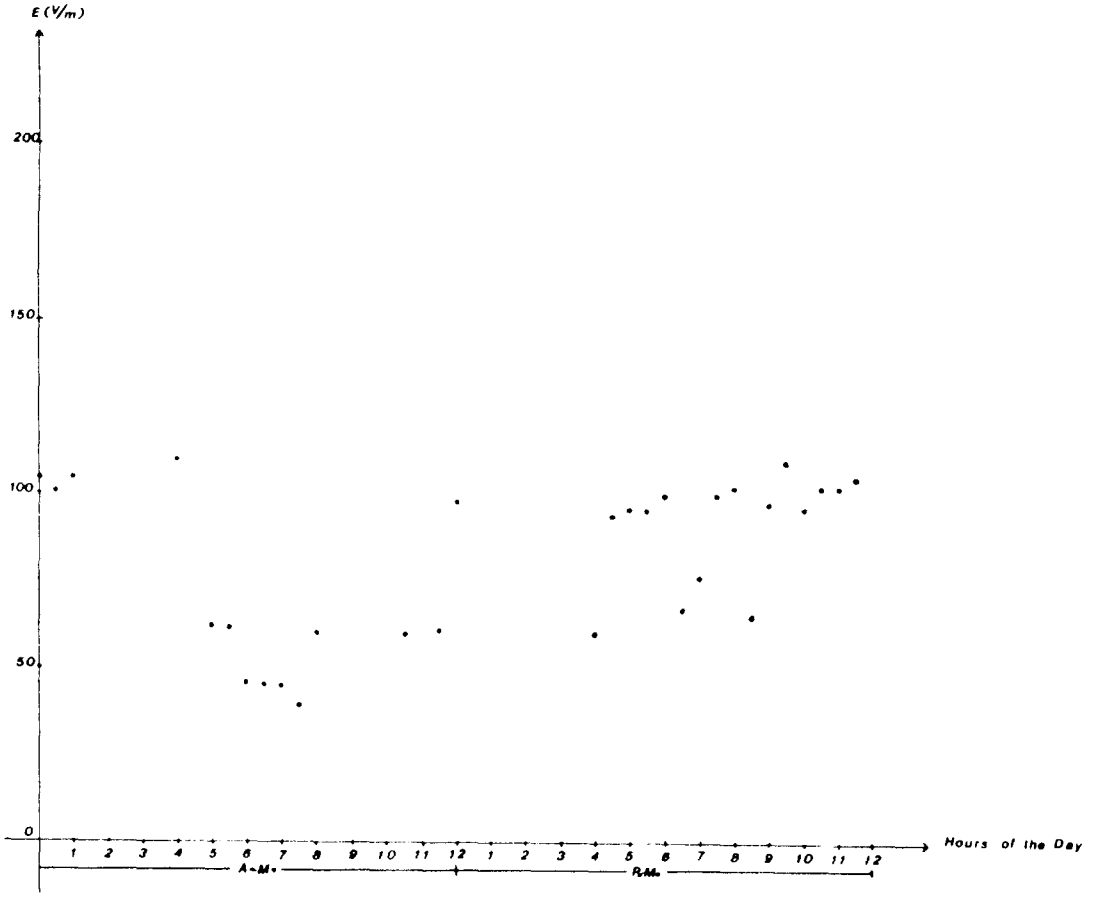
N.B. n_i = number of three series of measured values in the selected points:
(1, 2, 3) the day n;
(4, 5, 6) the day n + 1;
(7, 8, 9) the day n + 2;

$\bar{n}_i$ = each values represents the mean of other three measurements made reciprocally at 90° out of phase;

$\frac{\sum \bar{n}_i}{N}$ = the mean values relative to three measurements in three different days, but at the same hour of the day.

TABLE 1: Recording Chart of Detected Values for Every Selected Points

G R A P H 1



GRAPH 1: Electric Field Strength at the Different Hours of the Day