Kontinuirano praćenje nivoa elektromagnetnog polja

Continuous monitoring of the electromagnetic field level

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Sadržaj – Ovaj rad opisuje motive i razloge za implementaciju sistema za kontinuirano praćenje i merenje nivoa elektromagnetskog polja. Obezbeđuje pregled lokacija od interesa, konfiguraciju merne opreme kao i prikaz portala dostupnog stanovištvu za uvid u rezultate.

Abstract – This paper presents the background and objectives for implementation of the system for continuous measurement and monitoring of the level of the electromagnetic fields. It provides overview of the locations of interests for electromagnetic field level measuring, configuration of the equipment and publicly available portal EMF RATEL on RATEL's website.

1. INTRODUCTION

The rapid development of technologies, wireless radio systems, enormously increased number of radio transmitters, and exponential growth of the number of mobile devices, have contributed to the increase of public concern about the impact of such systems on the environment.

The Regulatory Agency for Electronic Communications and Postal Services (RATEL), among other things, is responsible for the rational and economical use of the radio frequency spectrum in the Republic of Serbia. Due to this fact, RATEL implemented a system for continuous monitoring of the electromagnetic (EM) field level. The intention is to reduce concern and present information to the public in an understandable format.

Likewise, the objective for the implementation of this system is reflected in the aspiration to launch public discussions and provide education in order to achieve confidence among all parties, whether they are citizens, operators or government institutions.

This project tends to meet some of the main goals which are:

- Comprehensibility: Results should be clear and comprehensible for the general public, without excessive technicalities. It is important to show the measured results compared to the applicable limit values;

- Accessibility: Results should be published on the Internet, and the access to them should be easy for the general public;

- Details: All possible information about how the measurements are being taken, description of the measurement location, description of the measurement method, the results of electromagnetic and exposure level should be provided.

2. DEFINED NORMS AND LOCATIONS OF INTEREST

The selection of locations that are the subject of the project is based on legal regulations and accompanying documentation:

- The law on protection against non-ionizing radiation,
- Rulebook on the limits of exposure to non-ionizing radiation,
- Rulebook on non-ionizing radiation sources of special interest, the types of sources, the manner and the period of their examination.

These rules define the zones of increased sensitivity which are the locations of interest in implementing the EMF RATEL system. These sites are residential areas where people can stay even up to 24 hours a day: kindergartens, schools, maternity hospitals, hospitals etc. [1] - [2].

Also, these rules define norms as well as the values that must be met in regard to the influence of electromagnetic fields on the environment. Thus, for example, the Rulebook on the limits of exposure to non-ionizing radiation have defined basic constraints

that represent limitations in exposure to time-varying sources of the electromagnetic field, as well as reference boundary levels that represent the level of exposure of the population to electromagnetic fields, and serve as a practical assessment of the exposure in order to determine whether there is the probability that basic constraints will be exceeded. The reference boundary levels are determined based on the field level, according to the following parameters: the electric field strength E, the magnetic field strength H and the power density S. The reference levels for general public exposure are given in Table 1.

Frequency range	E-field strength (V/m)	H-field strength (A/ m)	Equivalent plane wave power density S (W/m2)
up to 1 Hz	5600	12800	-
1–8 Hz	4000	$12800/f^2$	-
8–25 Hz	4000	1600/f	-
0.025–0.8 kHz	100/f	1.6/f	-
0.8–3 kHz	100/f	2	-
3-150kHz	34.8	2	
0.15–1 MHz	34.8	0.292/f	-
1–10 MHz	$34.8/f^{1/2}$	0.292/f	-
10–400 MHz	11.2	0.0292	0.326
400–2,000 MHz	$0.55f^{1/2}$	$0.00148f^{1/2}$	f/1250
2-300 GHz	24.4	0.064	1.6

Table 1: Reference levels for general public exposure

3. EM FIELDS MEASUREMENT

Using the appropriate measuring instruments, the values of the EM fields that exist in real conditions are being obtained. In the high frequency area, the intensity of the electric field is always measured, which uniquely determines the level of the EM field. [3].

All measurements must be carried out with metering systems that are standardized. Measuring instruments can be classified into two categories:

• Instruments that measure the level of EM fields by individual frequencies (frequency selective testing),

• Measuring instruments for broadband testing, which determine the cumulative contribution of all surrounding sources.

The long-term monitoring technique of the EM field is the most advanced approach to testing the EM field. Its goal is to obtain information on the behaviour of the source over a longer period, or to determine the time change of the level of the EM field.

Long-term monitoring techniques provide a detailed insight into the daily changes in the EM field level.

The EMF RATEL system is a concrete implementation of the long-term monitoring of the EM field level, using measurement sensors bound in a unique network, covering certain locations on the territory of the Republic of Serbia [4].

The EMF RATEL system is based on wireless sensor networks implemented on locations of interest, with aim to monitor and measure, using broadband measurements probes, overall level of electromagnetic field strength.

Within this approach, broadband measuring equipment is used, which measures the cumulative contribution of all active sources at a given location. The broadband probe provides an independent measurement of the frequency, which integrates all of the emissions in a broadband frequency band. The continuous broadband monitoring is being performed according to the Recommendation ITU-T K.83 and it takes 6 minutes averaging [5].

If necessary, broadband measurements can be replaced with frequency selective measurements in cases where additional analysis needs to be carried out. Using selective measurement approach, it is possible to provide results of EM field level for each defined frequency band and to determinate the contribution of a particular technology separately.

The broadband sensor unit, used in this project on one of the locations, is shown in Figure 1.

Figure 1. Broadband sensor unit

4. CONFIGURATION OF MEASUREMENT EQUIPMENT

The broadband sensors are used initially to calculate the total intensity of the electric field in the whole frequency band of the measuring equipment, in the range from 100 kHz to 7 GHz. These sensors are designed for fixed installation at the locations of interest. Each sensor has a solar panel, as well as a rechargeable battery that guarantees autonomy. Also, the sensors have internal memory for data storage and a 3G modem that allows sending data to the FTP server from where data is downloaded, processed, and finally publicly displayed [6]. The architecture of the complete EMF RATEL system is shown in Figure 2.

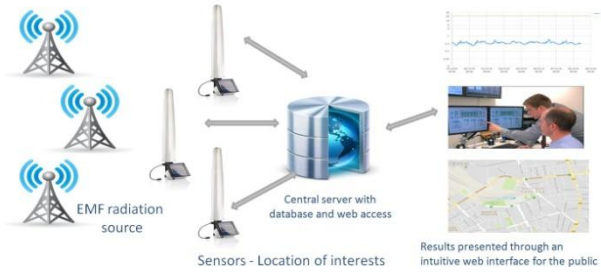

Figure 2. System architecture for continuous monitoring of the electromagnetic field level

For each sensor it is possible to configure the time when the data will be sent to the FTP server, how often during the day, and the time interval when the 3G modem will be active for that purpose. Also, for each sensor, alarms could be defined through the SMS communication system. These alarms include: exceeding the allowed limits for the electric field strength, the battery capacity below the defined threshold, the cap on the sensor unit being removed, the temperature alarms and the alarm that warns of the humidity of the air. Each sensor supports USB, RS232 and Ethernet interfaces so that the initial configuration is performed by direct communication, and later, the configuration can also be performed by using the commands via SMS communication.

Figures 3. and 4. present the settings for sending data to the FTP server, as well as the alarms that are active for a particular sensor. As shown in the picture, the following is being defined: setup time for the modem activity, the time from which the sensor should take the data and send it to the server.

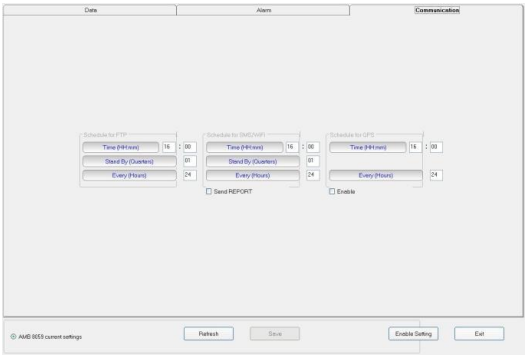

Figure 3. Configuration of the time when the data will be sent to the server

All defined alarms are visible in the administrative part of the portal, where it is also possible to perform any additional settings of the sensors. The administrative part of the portal could be accessed by the authorized personnel only.

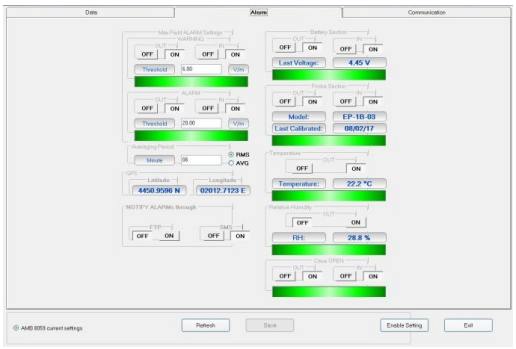

Figure 4. Defining the alarms that will be active on the sensor unit

5. PORTAL

In order to transparently inform the general public about the real-time EM field level and the EM influence to the environment, RATEL has developed a portal where all these results are available.

The portal is designed to show the real values of sensors that have already been implemented at the locations of interest, to educate the population, and to point to all of the accompanying legal documents in this area, Figure 5.

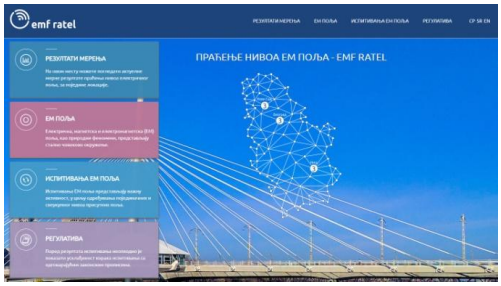

Figure 5. EMF RATEL portal

The portal is designed to contain section where the results of the measurement are located and the sections of an educational and informative character that discuss the EM fields and the way how EM field calculation is being performed [7].

It is possible to access the measurement results for every sensor implemented within EMF RATEL system. Once every sensor collects the data and sends it to the FTP server, the data is being processed transparently and individually shown on the portal, in the form of a graph, as presented in Figure 6.

Figure 6. EM field level at the specific location

Also, at any moment, it is possible to compare the obtained values with the minimum permitted EM field level limit, in accordance to the “Rulebook on the Limits of Exposure to Non-Ionizing Radiation" ("Official Gazette of the Republic of Serbia", no. 104/09).

In addition to the level of the electromagnetic field, the portal also provides the value of the EM field exposure, as well as the upper and lower exposure borders, with note that the real exposure is being located between these two comparative values, as presented in Figure 7.

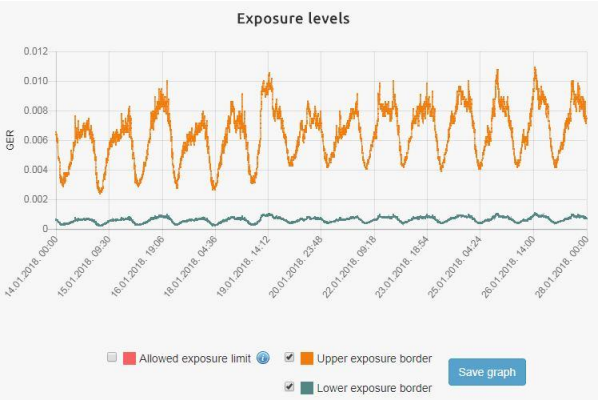

Figure 7. Global exposure level for specific location

For both of these parameters, there is a possibility to choose either the time period in the past when the sensor was active or the specific period of the day to see which value has been achieved.

It is also important to note that all the results of each measurement and all information needed to interpret the estimation are published accurately, clearly and objectively and in accordance with standard EN50492:2008 [8].

6. CONCLUSION

As stated in the paper, the main objective of the project is to continuously monitor the EM field level at the location of interest, which represents location of increased sensitivity. Likewise, the intention is to increase the awareness of citizens about the levels of EM fields that surround us and to provide education in this area.
Of great importance is the publicly accessible portal that is designed in a manner that all institutions that are interested in this project can implement sensors to the EMF RATEL portal and thus make the network of sensors more detailed and the whole project more socially responsible.

REFERENCES

[1] The Rulebook on the limits of exposure to non - ionizing radiation

[2]The Rulebook on non - ionizing radiation sources of special interest, the types of sources, the manner and the period of their examination.

[3] EMF RATEL Website < http://emf.ratel.rs >

[4] ICNIRP guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 ghz)

[5] Recommendation ITU-T K.83 -Monitoring of electromagnetic field levels

[6] AMB-8059 multi-band EMF area monitor User’s Manual

[7] EN 50383 (2010), *Basic standard for the calculation and measurement of electromagnetic field strength and SAR related to human exposure from radio base stations and fixed terminal stations for wireless telecommunication systems (110 MHz-40 GHz).*

[8] EN 50492:2008 – Basic standard for the in-situ measurement of electromagnetic field strength related to human exposure in the vicinity of base stations, 2008.