ASSESSMENT OF COMPLEX MICROWAVES OCCUPATIONAL EXPOSURE IN RADAR MAINTENANCE ACTIVITY

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INTRODUCTION

The modern development of the society has determined the increase of thousand times greater than the natural fond of the humankind exposure to a complex combination of electromagnetic man-made fields and radiations of extremely various strength and frequencies (4).

A special contribution to this environmental change has had in the last decades the appearance and the explosive development of the microwaves generating appliances such as radars used in a great variety of military and civilian applications and which essentially contributes to the electromagnetic pollution (4,6,7).

In the above mentioned context which firstly interests the occupational environment, it is necessary to improve the exposure limits, as well as, the emission standards, in order to better protect the human health and well-being (7). From this point of view, the estimation of the microwaves occupational exposure risk constitutes, alongside the health status assessment, one of the priorities of the Occupational Health because the theoretical and practical problems related to the bioeffects of this kind of radiations are far to be clarified.

Our study has been carried out in a factory where one performs research, production and especially maintenance of microwaves generating devices.

OBJECTIVE

To thoroughly analyse the working conditions, both ergonomical and physical, and to colligate them in order to obtain a better exposure assessment for the improvement of the protection of the microwaves exposed workers.

METHODS

Ergonomical analyse has comprised the study of all the postures, movements, gestures, physical and psychological charges of the workload, as well as, the study of all the partial timing for obtaining reliable photographs of the day-time work. The technical features of the radars (constructive as well as functional) and the relative distances between them and the workers in every phase of the work have also been studied.

The assessment of the presence, frequency and the average power density of the microwaves has been performed by a Russian PO1 measuring instrument with a set of probes able to measure electromagnetic fields in the range 10 Mhz - 12 Ghz, the provided parameter being the average power density (mW/cm^2). Multiple measurements for each type of radar and for each position in the activity have been done according to the methods described in the NCRP Report No. 119 "A Practical Guide to the Determination of Human Exposure to Radiofrequency Fields" (1993), (3).

As a result of the correlation between the ergonomical studies and the physical measurements, average and local Specific Absorption Rates (SARs) have been assessed by using the methods and diagrams from the "Radiofrequency Radiation Dosimetry Handbook (Fourth Edition)", C.H. Durney,1986, (1).

RESULTS

The activity is performed in relative small work-spaces with glass walls in metal frames and there are multiple, unshielded and rather close microwaves generating devices.

The working position is generally sitting down at tables and benches, but also standing up and in bent position. The motor solicitation both static and dynamic is rather reduced with the preponderance of the gesture that requires precision. The psychological solicitation implies: the thinking, the constant attention, the memory, the visual and auditive perception.

The generators emit in the range 0.2 - 10 Ghz with mean emission powers from some watts to hundreds of kilowatts and the waves are usually modulated as impulses. During the tests the devices usually run at nominal parameters and the shielding carcasses are removed, so multi-directional and variable power leakages occur generating complex field distribution, with extremely various power densities and frequencies.

It is to be mentioned that the physical phenomena like reflection and dispersion of the microwaves favoured by the characteristics of the workplaces could determine sensible increases of the local fields up to four times owing to the stationary waves and/or to the multiple interferences. The work positions create exposures both in near and in far field which especially concern the hands, the head and the fore part of the trunk. The movements multiply the complexity of the exposure and make more difficult its appropriate assessment. Thus it is obvious that there are complex conditions of continuous (sometimes quick) variations in space and time of the frequencies and power densities with frequently potential additional effects.

The measurements in normal work conditions for 15 types of generators in each stage of activity are synthetically presented below in terms of the frequency.

For the frequencies 8-10 Ghz we have found average power densities between 0.01 and almost 10 mW/cm^2, with averages for the different points that define the workplace of 0.8-2 mW/cm^2. At frequencies around 2-6 Ghz, the average power densities were 0.04-0.5 mW/cm^2. At frequencies smaller than 2 Ghz the measured values were between 0.3-1 mW/cm^2. It is to be especially mentioned the found values of many mW/cm^2, that exists in accidental conditions at many devices but the weight of which during the worktime is difficult to be established.

Based on the photographs of the day-time work, and on the physical measurements, we have estimated a wide range of various whole body SARs: 0.01 - 2 W/kg. There is a great variation during the day-time work of the estimated SARs at the same subject, which shows on one side the complexity of the exposure conditions and on the other side the wide range of possibilities of interference of the microwaves with the human organisms. There are also many inter-individual differences depending of the device being repaired, of its situation in the workplace and of the specific phase of the activity.

Trying to calculate some time-weight averages of the whole body SARs, we have found values of 0.08-0.31 W/kg which are under the threshold considered by IRPA and WHO as a basis for the setting of the occupational exposure limits ().

The local peak SARs, even more difficult to estimate, were greater for the head (neck) and hands (wrists), their values being of few ten times greater than the average whole body SARs. However, there is a highly non-uniform spatial and temporal distribution of local SARs which reflects the same complexity of the exposure conditions.

CONCLUSIONS

The workload implies continuous and various movements with consecutive great variations of partial and total exposures to complex field distribution, with extremely various power densities and frequencies, generated in a close and small workspace by multiple unshielded generators.

Although we have found whole body SARs values of 0.08-0.31 W/kg which are under the IRPA threshold of 0.4 W/kg (2,5,6), we consider that the peak values of both whole body SARs and local SARs are quite important, as well as, the pulsed character of the emission and consequently we consider that supplementary limits for pulsed microwaves as recommended by the documents of IRPA and WHO, are to be further enhanced and implemented in national legislation.

Beyond its laborious characteristics, this method allows a rather reliable exposure assessment, which could be used in setting limits for special exposure conditions, in order to avoid hot spots and, consequently, to improve the protection measures.

REFERENCES

1. Durney C.H., Massoudi H., Iskander M.F., Radiofrequency Radiation Dosimetry Handbook (Fourth Edition), USAFSAM, Brooks AFB, TX, USA, 5.1-5.47, 6.1-6.52, (1986);

2. IRPA, Health Physics, 54, 1, 115-123. (1988)

3. NCRP, A Practical Guide to the Determination of Human Exposure to Radiofrequency Fields, NCRP Report No. 119, 68-130, (1993).

4. NRPB, Electromagnetic Fields and the Risk of Cancer, Documents of the NRPB, Vol. III, No.1, 4-34, (1992)

5. Szabo D.L, Centr. Europ. J. of Occup. and Environm. Medicine, 1,3, 266-285, (1995);

6. WHO, Electromagnetic Fields (300 Hz to 300 Ghz), EHC 137, Geneva, 36-194, (1993);

7. WHO, Nonionizing radiation protection, Second edition, WHO Regional. Publ., Europ. Series, 25, Copenhagen, 117-175, (1989).