

Impact Evaluation of Electrical Equipments on Human Health

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Abstract : The complex character of the issues the scientific community is confronted with at present includes, besides chemical pollution, exposure to electromagnetic fields of different intensities and frequencies. If chemical pollution has made the object of numerous studies with actual results, the effects of exposure to electromagnetic fields are not as well-known. The present study aims at investigating the effects of the electromagnetic fields on the health of the personnel exposed to this type of noxe. In order to evaluate the health state of the personnel exposed to the possible influences of the electromagnetic fileds generated within these stations on the homeostasy of the human body, a medical investigation protocol, including clinical, neuropsychological, functional investigations, laboratory exams of the biological products (blood, urine), has been devised for establishing the hematological and biochemical constants. The present study also determies the levels of the melatonin neurohormone synthesis and secretion through the ELISA method. This has also represented a major difficulty in establishing a harvesting protocol enabling us to register the variable, physiological concentrations of the hormone, its metabolism, respectively, as accurately as possible. **The harvesting protocol is new and unique in this field.** As it is difficult to be carried out at the site, the harvesting protocol has been applied in the clinic, with the subjects admitted to the clinic. The protocol presupposes the harvesting of a urine spot for each urination over 48 hours. This procedure has allowed us to notice the circadian variations and the possible influence of the electromagnetic fileds due to the fact that some of the subjects that have been admitted during the two day perio of time have worked at least one shift. The results obtained and presented in this study are partially confirmed by other similar studies. In the course of time, the initial functional disorders of the melatonin circadian secretion rhythm have been followed by circulating concentration diminishing, and, after this, by the imbalance in the human body mechanisms protecting it against the free radicals. This effect could be compensated by increasing the intake of natural antioxidants such as food (vegetal) rich in carotenoids. Considering the experimental results obtained and corroborating them with the results at the international level, the research could be continued over a new period of time on the same subjects, in the same substations.

Key-Word : electric and magnetic field, melatonin neurohormone, circadian secretion rhythm

1. Introduction

The complex character of the issues the scientific community is confronted with at present includes, besides chemical pollution, exposure to electromagnetic fields of different intensities and frequencies. If chemical pollution has made the object of numerous studies with actual results, the effects of exposure to electromagnetic fields are not as well-known. The present study aims at investigating the effects of the electromagnetic fields on the health of the personnel exposed to this type of noxe.

In previous studies, complementary aspects relating to the health of the operating personnel from the electric substations that may have been affected by problems that could be included in the electromagnetic compatibility category have been examined. As a result of these studies, remedies to the major problems in this field could also be identified. Most of the damaging effects that have been encountered in the course of time have been related to the voltages and currents induced in the metallic structures or objects that are not properly grounded. In the case of the electric substations and overhead high voltage lines, the corona discharge also generates noise in the acoustic or electromagnetic spectrum, affecting the public activity in the nearby areas.

For a number of years the concern of the public relating to the possible negative effects of the low level and low frequency electric and magnetic fields, both on the health of the operating or residential personnel in the nearby of the sources of such fields, has increased.

In principle, the electric and magnetic fields whose frequency varies between 0 Hz (continuous voltage installations) and 30 kHz, with intensities in the air of up to 20 kV/m, 50 mT, respectively, are considered.

As regards the high frequency electromagnetic radiation (300 kHz ÷ 300 GHz), this has captured the interest due to the spectacular evolution of the technical microwave applications, in particular due to radiotelephony. The studies on this phenomenon are included in the larger field of bioelectromagnetism and are carried out in the field of epidemiology, of the laboratory studies and dosimetry.

At low levels of exposure and in the absence of the thermal effects, some effects have been noticed in the laboratory. At present, the research activities focus on the independent reproduction of these first conclusions. Until now no risks to health have been identified in cases where exposure **has not** led to thermal effects in the radiated organism, too. In the

high frequency field, research has concentrated on the mobile phones, on the effect of the field they radiate in the close vicinity of the human brain.

Special attention has been given to the low frequency electromagnetic field generated by the high voltage transmission and distribution grids, internal distribution networks, low voltage electric equipment (apparata) and video terminals.

Numerous independent organizations such as US Environmental Protection Agency (USEPA), World Health Organisation (WHO), National Radiological Protection Board (NRPB) and International Radiological Protection Association (IRPA) have developed a large number of reports in this field.

Concern about the possible negative effects on the health of the personnel working in areas of the electric and magnetic fields generated by the electric installations (even by the low voltage ones) has been registered. The main aspects from this point of view are related to the ions and ozone resulting from the corona discharge. Some reports on the involved electric phenomena and on their possible consequences have further increased the concern of the electric substation personnel and of the specialists who, unlike the former, could reproduce the claimed effects by systematic studies.

Every time, they have led to the conclusion that there was no clearcut indication of the influence of the low voltage electromagnetic field exposure on the incidence of certain affections (cancer, especially).

2. Theoretical aspects relating to the electric and magnetic fields

In spite of the numerous studies carried out so far, epidemiologists are still uncertain whether individual exposure to extremely low frequency electromagnetic radiations can be associated with certain effects on human health.

One of the bio-effects that has been frequently noticed is the change in the production, secretion or utilization of a hormone secreted by the pineal gland located in the brain, a hormone that is commonly known under the name of melatonin. Melatonin (5-methoxy -N- acetyltryptamine) is a chemical mediator playing an important role in the human body and that is why the alteration of its level can be associated with a wide range of pathological conditions, including cancer. Due to this potential association when melatonin was found in low concentrations in the laboratory animals exposed to the electromagnetic fields it was assumed that this reduction could explain the higher than normal

incidence of cancer in the people living in the nearby of the high voltage electric lines.

The synthesis and secretion of the melatonin follows a circadian pattern, reaching the maximum production during nighttime. The electromagnetic radiations, light, determine the normal amount of melatonin produced within 24 hours. Light has two main (primary) effects on the production of melatonin by the pineal gland:

- It synchronizes the circadian rhythm, thus limiting the production of melatonin when it is dark;
- It marks the reduction in the melatonin production when people and lab animals are exposed to light during nighttime.

Melatonin behaves like an antioxidant in the body. Many studies point out that exposure to the electromagnetic fields generates a higher rate of different cancer types than the normal one. Melatonin administration to the lab animals reduces the increase in the initial or transplanted tumors, while pinealtomia reduces the level of melatonin and accelerates the tumor increase. Such conclusions point out that an increase in the level of melatonin during nighttime can hinder the increase in the already existing tumors. In contrast, any factor, for example exposure to light or electromagnetic radiations, reduces melatonin production during nighttime, enabling acceleration of the tumor cell increase as the oncostatic agent has been lost.

In the human body, the reduction in the melatonin production rhythm has been often associated with the tumor increase. In the women who have breast cancer and the men with prostate cancer it was found that the nocturnal melatonin peak was attenuated, the total melatonin being less than in the investigated individuals without tumors. As there is no clear evidence, these individuals are supposed to have developed cancer due to a lack of an adequate reserve of this natural oncostatic hormone. Anyway, experimental studies have pointed out that high melatonin levels diminish the tumor increase while low levels accelerate the tumor cell proliferation.

Other experimental data indicate, through the exposure to the electromagnetic field, the melatonin production and cancer initiation. In 1993, melatonin was reported to be the most efficient scavenger discovered for the hydroxyl radical. The free radicals of oxygen, including hydroxyl, can be very toxic and affect the DNA, thus favoring cancer occurrence.

At the same time, it has been noticed that melatonin is a potential scavenger for the peroxi radical. The peroxi radicals can initiate secondary cancer.

Another activated form of oxygen, the singlet oxygen, seems to be neutralized by melatonin. The singlet oxygen is toxic enough so that it can partially affect the DNA base.

Finally, melatonin has been indicated as stimulating an important anti-oxidant enzyme, glutathion peroxidase. Considering these antioxidant effects of the pineal melatonin, as well as the role of the free radicals in cancer initiation, any factors, such as the electromagnetic fields, or others, that reduce the endogen levels of melatonin, could be expected to increase cancer probability. The protective effect of melatonin against the oxidative effects of DNA is also supported by the observations that melatonin is to be found in great concentrations in the cell nuclei. These theories explain the reports in which the increased cancer risk is associated with the exposure to power electromagnetic fields. These theories underline the importance of reducing the level of melatonin produced and secreted by the pineal gland.

Melatonin has become well - known for its anticancer action in the experimental studies. Thus, melatonin can prevent cancer initiation by reducing the frequency with which the DNA is attacked by the free radicals. Melatonin reduces the increase in the cancer cells in human cultures. The breast cancer cells, as well as other types of human tumors, are inhibited by the presence of melatonin. A variety of tumors, both hormone dependent or independent, have been associated with the electromagnetic exposure.

The decrease in melatonin reduces the total antioxidant potential of the human body because it plays a scavenger role on the free radicals of the oxygen. This fact alone could determine a small increase in the initiation of cancer. In the last years a number of researchers have suggested that the free radicals, that are paradigmatic molecules, can be influenced by the applied external electromagnetic fields.

The halving time of the free radicals, in particular, may increase in the presence of the magnetic fields. It was supposed that the recombination of the free radicals can be delayed by the magnetic fields this way prolonging the halving time. Thus, the probability of their interaction with the DNA increases and the number of the affected DNA molecules will be greater.

Therefore, the antioxidant protection mechanism is less efficient during the exposure to the magnetic fields due to the melatonin level decrease and, if this is coupled with the increase in the free radicals halving time, normally produced as a result of the oxygen metabolism in cells, the frequency with which all the cells are affected, the DNA ones,

especially, could increase, too. This association may favor an increase in the risk of cancer.

Another factor can be also added to this scheme. A variety of processes (for example, the ionizing radiations from the environment) and toxins (carcinogenous, herbicides) generate free radicals in the cells. In the individuals whose protection system is compromised by the exposure to the electromagnetic fields and the free radicals have a halving time greater than normal, generation of supplementary radicals can create an important detriment. The researchers have agreed on the fact that the electromagnetic fields cannot cause homolythic scissions (breakage) of the covalent bonds that can generate the formation of the free toxic radicals, but electromagnetic fields can increase the risks of exposure in the processes or substances that initiate, in fact, the generation of free radicals. The briefly presented theories are not exclusive. All the processes, for example the reduction in melatonin, increase in prolactine and estrogens and the increase in the halving time of the free radicals can contribute to the increase in the breast cancer incidence by initiating certain DNA affections and by promoting the already existing tumors. These interactions are currently tested on lab animals and are simultaneously clearer defined by the epidemiological studies that are trying to determine whether there are effects associated with the human exposure to electromagnetic fields.

The epidemiological studies and most of the experimental investigations that have been carried out on the exposure to electromagnetic radiations have led to the identification of a potential risk of cancer and, if the free radicals area component of this risk, then a series of other effects occur. A great number of affections and ageing can occur at the same time with the generation of the active oxygen species, such as the free radicals of oxygen.

No clear conclusions could be drawn as regards the effects of exposure to the electromagnetic fields due to this ambiguity, the efforts will intensify and there is hope that in the future they will lead to conclusive answers. If the melatonin reduction in the human body is one of the consequences of exposure it is easy to rectify this deficiency; melatonin can be found in a number of plants used for food; more than that, melatonin is not toxic and is quickly absorbed. Thus, the melatonin supplement could represent a treatment for the individuals with less melatonin than the normal level due to the exposure to the electromagnetic fields or other causes.

Further, a synthesis of the results of seven years of investigations tackling the main aspects, as well as the synthesis results will be presented. The

methodology that has led to these results and the values obtained are further presented.

3. Application overview (synthetical presentation)

At present, the focus is on the magnetic field generated by the electric installations, although both the electric and the electromagnetic fields are present at the same time in the area where these installations are located.

By examining the experimental results registered in cele 3 electric substations of CN TRANSELECTRICA S.A company, maximum values have been identified at the level of the individual substations presented in Table 1.

Table 1

The maximum values of the electric and electromagnetic fields in the electric substations of S.C. TRANSELECTRICA S. A. (Monitored between 2001 and 2007)

Substatio n no.	Name of the electric substation	Voltages	$ E $ kV/m	$ B $ μT	Obs.
01	Dârste	400 kV/ 110 kV	22.44 (36.5)	11.39	MOP At the level of the lid With the lid open and
02	Lacu Sărat	400 kV /220 kV /110kV	20.83 (36.3)	20.1	
03	Brad	400 kV /220kV/ 110 kV	18.74 (36.7)	19.73	With the cell energized

- The values $|E|$ present in all the 3 substations, that are higher than 10 kV/m, have been registered as maximum values in the measurement points located around the drives of the circuit breakers of the MOP type.

Due to the measurements carried out in other operating conditions and the possibility to carry out measurements in working areas that have been de-energized, the determinations of the electric field have focused both on certain points of interest from the 400 kV electric substation and on the identification of the factors of risk to the personnel during the work hours (e.g. the measurement of the electric field intensity at the MOP equipment, from the front, with the lid open, at the lid top, (where maximum values surpassing 30 kV/m have been registered).

Very low values of the electric field intensity have been registered in the three objectives where the

measurements have been carried out, including the high work platform in the AT-s.

On the basis of these determinations and on the basis of those carried out in the electric substations in similar conditions, it has been established that the four working points, namely:

- The autotransformer revision works (at the soil level, within the working area)
- The disconnecting switch transfer coupling
- Transfer coupling MOP, with the lid open

(at 220 kV) pose no biological risks, regardless of the period of time spent there, the values being under the 10 kV/m limit.

Preliminary results concerning the health state of the personnel from the DARSTE-BRASOV, LACU SARAT-BRAILA, BRADU-ARGES electric substations

In order to evaluate the health state of the personnel exposed to the possible influences of the electromagnetic fields generated within these stations on the homeostasy of the human body, a medical investigation protocol, including clinical, neuropsychological, functional investigations, laboratory exams of the biological products (blood, urine), has been devised for establishing the hematological and biochemical constants.

The present study also determines the levels of the melatonin neurohormone synthesis and secretion through the ELISA method.

The focus on this hormone has been determined by the previous findings suggesting modifications of metabolism as a result of the electromagnetic field influence. The effect of the decrease in the melatonin secretion level could prove extremely important not only because this hormone plays a major role in regulating the sleep-wake relationship, but also because it seems that it acts as anti-cancer protection, too. Physiologically, melatonin is synthesized and secreted in an oscillatory way, according to the circadian rhythm, characterized by day and night, by minimum and maximum values, respectively.

This has also represented a major difficulty in establishing a harvesting protocol enabling us to register the variable, physiological concentrations of the hormone, its metabolism, respectively, as accurately as possible. **The harvesting protocol is new and unique in this field.**

As it is difficult to be carried out at the site, the harvesting protocol has been applied in the clinic, with the subjects admitted to the clinic. The protocol presupposes the harvesting of a urine spot for each urination over 48 hours. This procedure has allowed us to notice the circadian variations and the possible influence of the electromagnetic fields due to the fact that some of the subjects that have been admitted during the two day period of time have worked at least one shift.

4. Methodology

The health condition of the working personnel from the investigated high voltage substations has been evaluated considering the specific activity they carry out and their occupational exposure.

The clinical examination has been carried out on 44 persons (approximately 15 persons by each investigated electric substation), representing the operating personnel in the respective substations and has been completed by their neuropsychological exam and biological product harvesting for lab analyses.

The hematological determinations that have been performed referred to the study of the peripheral blood picture: number of red cells, hematocrit, average erythrocyte volume, hemoglobin concentration, number of white cells and the leucocyte formula.

These determinations have been carried out by means of the MINITRON equipment, manufactured by the Diatron company; the blood sample harvesting has been carried out on an anticoagulant (EDTA).

5. Clinical and psychomedical examinations

47 subjects have been examined three times consecutively over a 6 – year period of time in the three electric substations under investigation.

The results of these examinations have been registered in their medical sheets. On this occasion, associated pathology personal anamnestic data have been taken over, too. A questionnaire on previous occupational anamnesis (uninterrupted activity in a workplace, work places, occupational exposure, or no exposure, to different noxes) has been filled in as all this information (data) is useful for eliminating the confusing factors from the analysis, as well as for establishing, as homogeneously as possible, the groups for the endocrine determinations.

To this goal (namely identification of the possible confusing factors), data referring to random exposures to other electromagnetic fields besides

those at the workplaces (e.g: electronic equipment, mobile phones, residence location from the existing electric networks or radio antennas, etc.) have been also obtained.

The information relating to the sleep-wake rhythm of the subjects, residence and workplace night lighting have been put down as they have an extremely important influence on certain homeostasy values (circadian hormonal rhythm of melatonin).

The clinical examination has also included an electrocardiographic examination by means of the oscilloscope of the PULSONIC- 2000 type apparatus.

The structure of the investigated groups of subjects is given in the following tables.

Subject age

Substation	No. of persons	20 – 30 years	31-40 years	41–50 years	> 50 years
Braşov	16	3	10	2	1
Argeş	17	8	5	2	2
Brăila	16	3	5	5	3

Uninterrupted work time

Substation	1 – 5 years	6 – 10 years	1 – 15 years	16–20 years	> 20 years
Braşov	12,5 %	18,7 %	31,2 %	31,2 %	6,2 %
Argeş	35,2 %	11,7 %	17,6 %	5,8 %	29,4 %
Brăila	6,2 %	6,2 %	31,2 %	12,5 %	43,7 %

The biochemical investigations have concentrated on establishing:

- The degree the lipide metabolism has been affected, by means of triglyceride, cholesterol, HDL cholesterol determinations;
- The degree the liver has been affected, by means of serum transaminase determination (TGO si TGP);
- Calcium and magnesium;
- Blood sedimentation rate (BSR)

The investigated personnel has been mostly (about 80%) the same since 2001 until 2006.

The results of the investigations have pointed out that:

- The lipide metabolism has been affected (values of cholesterol and triglyceride concentration higher than the risk values of 200 mg/dl for triglyceride and 260 mg/dl for cholesterol) in the case of one or two persons by each investigated substation (Braila, Brasov, Pitesti) over the entire investigation period.

- Off-balance lipide metabolism correlated with liver affection has been encountered in only one case from the Braila substation.
- The other biochemical parameters have not been significantly altered.

We consider that the minor modifications that have been registered in the biochemical examinations cannot be correlated with the occupational exposure to the electromagnetic fields.

As regards the hematological investigations, they do not present significant modifications against the normal values.

6. The hormonal exams

A special protocol has been developed for urine harvesting in order to establish the doses of hormonal levels of the 6-hydroxymelatonin sulphate.

As all the subjects are active persons with a 12 hour work program followed by a 24 hour break and also considering the circadian rhythm (day/night of the physiological secretion of this hormon), in order to point out the influence of the occupational exposure fields, urine harvesting has been carried out on each subject for 3 days uninterruptedly, for each urination.

The registered values point out the influences of all the respective overlapping factors. This method is also advantageous because it compares the values registered for the same subject during similar periods of time. It is important to be able to make this comparison as the reliability of the secretion cycle for each person is very low; in other words, the comparison between the hormone levels of different individuals can be avoided, as it may generate confusions, considered as physiological.

Part of the affections that have been identified during the medical examinations, such as osteoarticular affections, certain digestive diseases (ulcer, gastritis) caused by stress or depression, may be related to the work conditions elements, etc., but are not directly influenced by the intensity of the fields.

Exception from the previous assertion make the hormone dosages. In this respect, in most of the subjects that have worked for less than 5 years this seems to be a phenomenon of secretion arrhythmia within the circadian rhythm, a situation that becomes less obvious in the patients with a longer professional activity. From the biological point of view, the aspect relating to the secretion curves could be interpreted as a phenomenon of organism

adaption and entering into operation of the homeostatic type mechanisms.

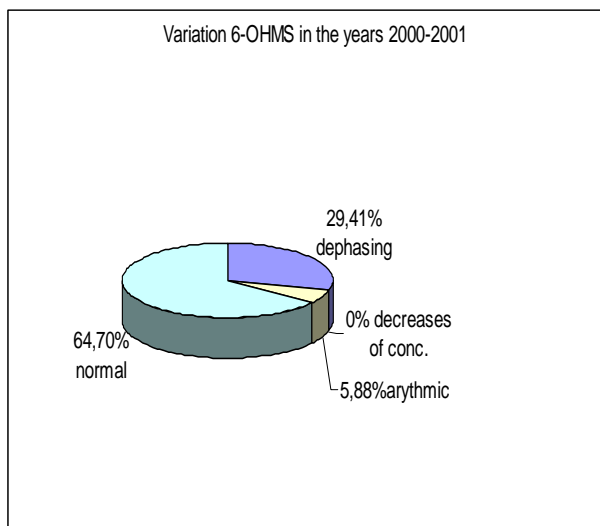
A relatively constant phenomenon, encountered in the case of the subjects who have worked more than 5 years, is secretion dephasing with the work hours. Less constant, but also significant from the statistical point of view, has been the phenomenon of melatonin secretion amplitude diminishing during the work hours in comparison with the periods of time when the subjects have not been exposed.

If we compare the three substations, relatively constant modifications have occurred in the subjects that come from the Lacu Sărat substation.

The following report presents the values registered at the beginning, middle and at the end of the period of study. The values from the intermediate years are within the same curves and, for better underlining the registered modifications, the variant of the synthetic presentation of the above mentioned years has been chosen.

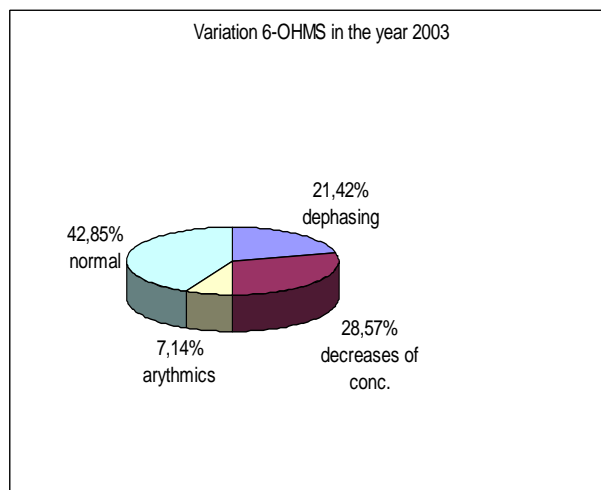
The synthesis and secretion of melatonin has been evaluated through the dosage of 6-sulfateximelatonin, the urinary metabolite of melatonin. In the case of the human being 90% of melatonin is metabolized in 6-hidroximelatonininsulphate (6-OHMS) and that is why the 6-OHMS concentrations in the urine quantitatively reflect the concentrations of serum melatonin.

In the first sets of determinations 64.70% of the subjects have registeres normal values for 6-OHMS, 29.41% presented dephasings of acrophase (maximum secretion) and 5,88% have presented arhythmic secretions of melatonin.

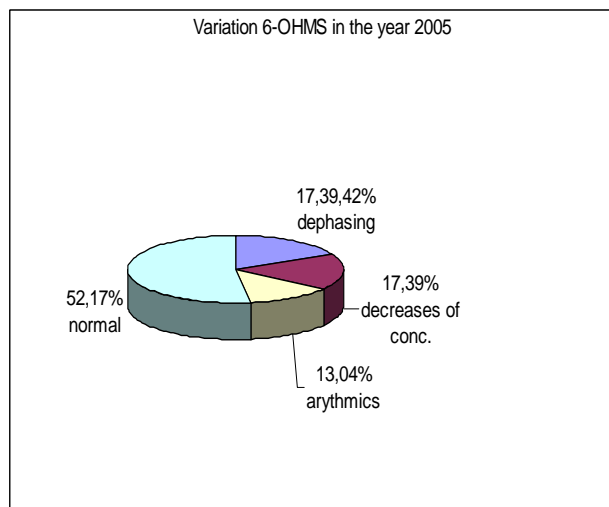


The determinations carried out in 2003 pointed out that 21.42% of the subjects presented

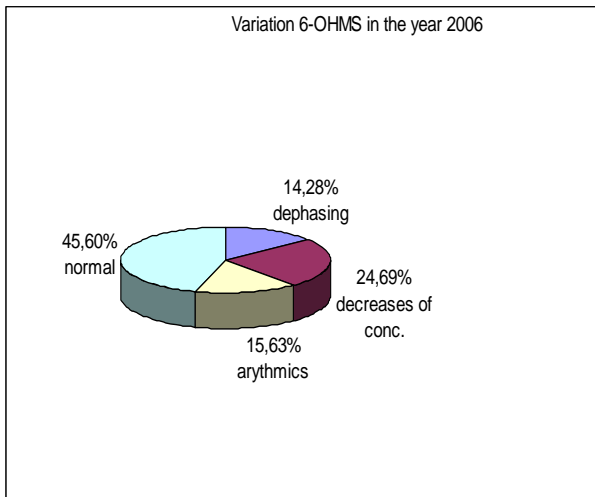
dephasing of the acrophase, 28.57% of the subjects had lower maximum concentration of 6-OHMS, especially during occupational exposure to electromagnetic radiation and 7.14% of the subjects had an arhythmic secretion of melatonin.



In 2005, 17.39% of the subjects presented acrophase dephasing, 17.39% of the investigated workers have had low values of the maximum 6-OHMS concentration, while 13.04% of the subjects had an arhythmic melatonin secretion.



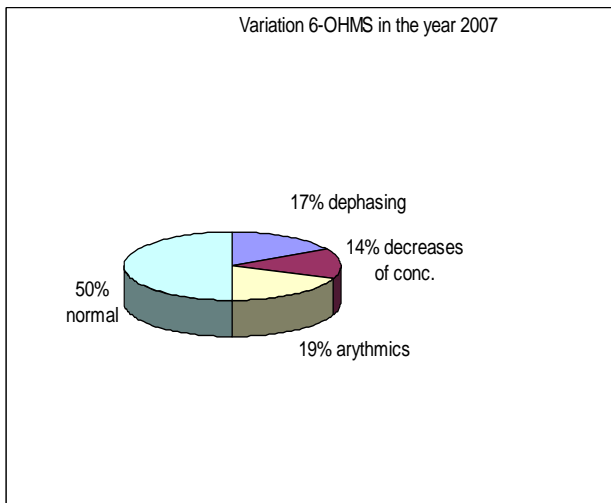
In 2006, 14.28% of the subjects presented acrophase dephasing, 24.69% of the investigated workers had low values of the maximum 6-OHMS concentration, while 15.63% of the subjects had an arhythmic melatonin secretion.



The analysis of the 6-OHMS concentration data has pointed out that the maximum secretion dephasing continued to occur (in 2007) in about 17 % of the subjects, by delaying it, and in about 14 % of the subjects, by secretion arhythmias.

These deregulations (disorders) have persisted even between the shifts, during the rest-time, especially in the subjects under the age of 40.

The phenomenon of metabolite concentration diminishing has continued to occur, especially then, when the comparison is made with the values registered in the previous years, in the same subject (21%).



By analyzing the data obtained during these 7 years there results that about 50% of the subjects have had a normal rate of production and secretion of 6-hydroxymelatonin sulphate, therefore melatonin, with normal values of the maximum registered concentrations.

The number of persons who have registered normal curves of 6-OHMS has decreased with time, thus

between 2001 and 2002, the normality percentage was of 64.70%, while in 2007 it decreased to 48%. Part of the investigated subjects have had maximum secretion shifts (acrophase) before, or later than the usual hour, thus influencing the circadian rhythm. Between 2001 and 2002, 29.41 % of the investigated subjects registered dephasings in the melatonin maximum secretion, the percentage slightly decreased in the years 2003 and 2005 to 21.42%, and 17.39%, respectively, the decrease being more accentuated in 2006, when 14.28% of the subjects registered dephasing in the acrophase registration hour. In 2007 a slight increase (17 %) in its value was registered.

A tendency towards the decrease in the maximum concentration of 6-OHMS has been noticed. The decreases in the 6-OHMS concentration were registered in 2003 (28.57%), 2005 (17.39%), 2006 (24.69%) and 2007 (21%). This has not been a constant phenomenon; it has appeared slowly, after several years of exposure and we are not certain whether it has been caused by the exposure to the electromagnetic fields or it is the result of ageing.

The maximum melatonin secretion dephasings registered in a great number in the first years of the study seem to have changed into arhythmic secretions in the last years, after a prolonged exposure to the electromagnetic fields. This is also supported by the results we have obtained pointing out that the percentage of arrhythmic secretions increases in the course of time. Thus, 5.88% of the subjects have presented arrhythmias in 2001-2002, the percentage increased to 7.13% in 2003 and to 13.045% in 2005, while in 2006 this increase was greater, attaining 15.63% of the investigated subjects and in 2007 the percentage was of 14%.

The modifications that have occurred in the production and secretion of melatonin seem to be more accentuated in the cold season than in the warm one.

The results of the melatonin determinations have been monitored for each of the analyzed subject during the seven year period of time. The results have pointed out that in 28.88% of the workers whose melatonin has been constantly determined, the secretion of 6-OHMS, that was normal in the first year or presented a slight shift in the maximum concentration, turned into an arhythmic secretion to the end of the investigation period.

The aspects presented above could be of the result of the exposures to the electromagnetic fields (knowing their effect on the immune system), but, in order to support this assertion, supplementary determinations and analyses, that, on the other hand, are scheduled for the following phases of the project, have to be carried out.

7. Conclusions

Electromagnetic field intensity can be reduced only by positioning the current paths in a relatively efficient way and/or locating the sources of the field as far from the protected zones as possible. This is true in the cases where the available space is not restricted, the case of the overhead electric lines more specifically. Nevertheless, in the case of the existing and future electric installations, where the available space is limited, the screening (passive or active) seems to be the only possible way to diminish the electromagnetic field.

For seven consecutive years three groups of subjects, selected from the personnel of the Lacul Sarat, Bradu, Darste substations, that have been exposed to the electromagnetic fields, have been placed under medical supervision. The medical supervision has been based on protocol of examination including clinical, functional (EKG, PFV) examinations, psychological evaluation, laboratory (hematological, biochemical) analyses and dosage of the urinary metabolite (6-OHMS) of the melatonin hormone.

The selection has considered the following criteria: the age (knowing that after the age of 45 the secretion level of this hormone decreases), occupational exposure to the electromagnetic fields (the personnel worked in three shifts). At the same time, the possible associated medical affections, random exposures to fields of this type (even the low intensity ones), such as the mobile phones, household appliances, antennas or other relays, located in the nearby of their residences, have also been considered.

From among the monitored parameters the melatonin hormone has represented the main point of interest, as its antioxidant role is well known, as well as the possibility to be influenced by the electromagnetic fields. Part of the research studies in the literature in the field underline the modifications of the circulating secretion levels of this hormone and, consequently, the possible negative influence on the human body protection against the free radicals and their effects (in oncogenesis, as well).

The synthesis and secretion of melatonin has been assessed by 6-OHMS dosing, which is the urinary metabolite and represents about 90% of the secreted melatonin, its concentrations following with fidelity the hormone curves (with a 2-3 hour shift). A major argument in favor in this respect has been the fact that both harvesting and dosing (from urine) are easy to perform, as the monitoring process has had

to cover a long period of time and repeated biannually.

The 6-OHMS dosage has required the development of a special protocol for urine harvesting.

As all the selected subjects are active people, with a 12 hour (24 hour break) working program, in general, and considering the day/night circadian rhythm of the physiological secretion of the hormone, urine harvesting has been carried out for each subject over a 3 day time interval without any interruption, at each urination, in order to be able to point out any possible influence of the occupational exposure to the fields. Two periods of harvesting (in spring and in autumn) have been organized each year during the period of the study.

This method is also advantageous as it enables the comparison between the registered values for the same subject in similar periods.

In the case of some subjects the results of the medical and laboratory examinations (biochemical and hematological) have pointed out a series of modifications suggesting different affections (osteoarticular, cardiovascular, digestive, etc.), that, statistically, do not present significant modifications neither against the personnel of the three substations, nor against the general population. These modifications do not seem to be directly related to the work conditions, and are not generated by them, but they could be influenced by certain factors, characteristic of the workplace (work in shifts, stress, etc.).

Extremely interesting results have been obtained in connection with the melatonin concentrations.

Until now, these results are to be found only partly in the literature in the field.

As known, the circadian secretion rhythm of this hormone registers a maximum concentration at night and a minimum during daytime, with rather great individual variations within the physiological range of values.

From the analysis of the obtained data the first effect that can be noticed is the presence of certain dephasings in the acrophase (maximum secretion) usually by delay. In the years of the study the percentage amounted to 29% (of the values), but in 2006 the percentage did not surpass 15%, and in 2007 it amounted to 17%. This decrease in the number of dephasings has an inverse evolution with the frequency of arrhythmias (up to rhythm inversions). During the first year of the study, arrhythmias represented about 5%, then 7.4%, in 2003 while in 2006 they surpassed 15%, and in 2007 they amounted to 14%.

This may be one and the same phenomenon, namely the dephasing of acrophasia up to the occurrence of an actual arrhythmia, sometimes even with the

inversion of the circadian rhythm. This is a progressive deregulation of the secretion and the phenomenon appears especially in the younger subjects with shorter uninterrupted work duration (about 10 years). This functional deregulation does not seem to be the result of the inversion of the circadian sleep /wake cycle due to the night shifts, as it keeps occurring during the periods of rest after the night shifts.

Another important result (this time mentioned in other studies in the field, as well) is the one relating to the melatonin metabolite concentration diminishing.

Over the seven years period of time, diminishings in the melatonin concentration have been noticed in 22.91% of the subjects. It is worth mentioning that the concentration values that have been determined have been also compared with the values from the same patient (and not only to the values considered normal, in general); thus, the comparison is much more representative and accurate.

At the same time, the fact that the age of these subjects varied between 35 and 47 at the time of the study, is also important as the diminishing caused by physiological factors (ageing) is not to be taken into account. The fact that, in general, the samples with lower concentrations have been harvested during the period of work implies the influence of the occupational exposure factor.

As regards the fact that the modifications in the melatonin concentrations have been more evident in the samples harvested in the autumn months than in those harvested in spring, no plausible explanation has been found yet, as the level of light during daytime, the ratio day/night, or the temperature variations have not differed so much to account for this.

The results obtained and presented in this study are partially confirmed by other similar studies. In the course of time, the initial functional disorders of the melatonin circadian secretion rhythm have been followed by circulating concentration diminishing, and, after this, by the imbalance in the human body mechanisms protecting it against the free radicals.

This effect could be compensated by increasing the intake of natural antioxidants such as food (vegetal) rich in carotenoids.

Considering the experimental results obtained and corroborating them with the results at the international level, the research could be continued over a new period of time on the same subjects, in the same substations.

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