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FUNDAMENTAL AND APPLIED RESEARCH**

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1. THE GENERAL PROBLEMS OF EMF INVESTIGATION

CONCEPT OF INFORMATION SUPPORT FOR MOBILE PHONE USERS SAFETY ON THE BASIS OF PRECAUTIONARY POLICY REALISATION IN PUBLIC HEALTH SERVICES.

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Mobile telecommunication is rapidly developing as an element of social technological infrastructure. However none of the specialised scientific organisation could confirm, that mobile phones EMF is unharmed for human health. Numerous researches reveals more questions than answers. World health organisation consider, that the consequences from mobile phones' EMF exposure of individuals as well as human population in whole aren't known enough, therefore we have to continue the scientific researches and provide the precautionary policy. According to precautionary principle we have to make all efforts to decrease the risk for human health, even finally unproved.

Mobile telecommunication systems drastic increasing, though we have no final results of EMF biological influence researches. It means that mobile phones' value for society is more important factor, comparing with real and possible risks for human health.

Refer to the law project "About the basis of technical regulation in Russian Federation" sellers should provide goods safety for consumers, this means that mobile phones' sellers and manufactures have to confirm their equipment safety. However it takes time to adopt the law and work out the mechanism of its realisation.

In such conditions we consider that the most actual and rather fast method to provide the population safety is let to know the objective and actual information that allows to generate own opinion and make realised choice in all aspects of the problem «Mobile phones and health».

Such programs should be aimed to mobile phones services' consumers (voluntary risk group) as well as to other population who don't use mobile phones, but exposed by mobile telecommunication EMF (involuntary risk group).

Now authors are developing the information support complex for population “Mobile telecommunication and human health”, which includes the web-site (www.ecopole.ru), popular scientific book and several leaflets names as “Mobile phones”, “Base stations”, “To children up to 16 is not recommended”

THE RUSSIAN NATIONAL COMMITTEE ON NON-IONIZING RADIATION PROTECTION AND PROBLEM OF ELECTROMAG- NETIC SAFETY OF THE POPULATION

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Now Russian National Committee on Non-Ionizing Radiation Protection carries out (spend) the constant analysis of achievement of scientific community on a problem of electromagnetic safety of the population, as well as recommendations of the World health organization (WHO) and International commission on Non-Ionizing Radiation Protection (ICNIRP). We also make an estimation of a real situation in the country.

The committee recognizes presence of a problem of probable adverse influence EMF on health of the population. For last 35-40 years we have a sufficient material giving an opportunity to establish dose dependence EMF, as well as influence frequency characteristics EMF on bioeffects.

However, now there is the important establishment fact of cumulation of bioeffects in conditions repeated and chronic EMF exposure of small intensity.

Pays on itself attention a completely new situation in connection with wide use of cellular communication. The large group of the users by cellular telephones has daily EMF irradiation of structures periphery of nervous system and head brain, on the one hand, and the overwhelming part of the population is exposed to a constant compulsory EMF irradiation from base stations, on the other hand.

There is till now unsolved problem of a role of EMF modulation in development of bioeffects. This problem practically is not taken into account in definition MPE of EMF.

The members of Committee give the large attention to a scientific substantiation and development of sanitary rules for EMF and harmonization of them with the international recommendations and standards, and also the decisions a WHO are taken into account.

THE PRECAUTIONARY PRINCIPLE AND EMF: IMPLEMENTATION AND EVALUATION

Leeka I. Kheifets, Gordon L. Hester, and Gail L. Banerjee

The precautionary principle, a recommendation to consider action to avoid a possible harm even if it is not certain to occur, is variously defined and interpreted. We present a range of definitions with an emphasis on their requirements for strength of evidence of harm and for actions to be taken. We describe the variety of approaches that have been adopted in developing policy to address the issue of possible health effects of electric and magnetic fields (EMF) in the face of scientific uncertainty. Further, we discuss specific aspects of scientific uncertainty regarding EMF health risks particularly relevant to the development of precautionary principle policy. We define and discuss prudent avoidance and other unique features of applications of the precautionary principle to EMF. We conclude with examples from EMF policy decisions of risk tradeoffs that need to be considered in developing any precautionary principle policy, and provide recommendations for better ways to define and implement the precautionary principle.

HUMAN RESPONSE TO RADIO FREQUENCY RADIATION: AC- TIVITIES OF THE U. S. AIR FORCE RESEARCH LABORATORY

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The Air Force Research Laboratory operates one of the largest centers in the world on the bioeffects of RFR. Its main mission is addressing the health and safety of emissions from existing and emerging military systems. To address Radio Frequency Radiation (RFR) emitters are utilized for a number of military (and civilian) tasks, especially communications and RADAR. New RFR emitting systems under consideration for anti-electronic applications will undoubtedly increase the opportunity for human exposure to HPM and UWB pulses. Furthermore, an RFR system in the millimeter range has been proposed for non-lethal military applications. Other commercial and medical applications of RFR bioeffects may be feasible.

this mission, we conduct original research on the bioeffects of RFR, using a multidisciplinary approach involving exposures to cells, tissues, and whole organisms, including humans. We also accomplish practical,

experimental, and theoretical work on RFR dosimetry. The results of both the biological and dosimetric research are transitioned to military and civilian standard setting bodies for consideration in establishing human exposure limits.

This presentation will provide an overview of the whole USAF RFR bioeffects program, with a focus on human response RFR exposure in the frequency range from 100MHz to 95GHz.

This communication represents the opinion of the author and not that of the United States Air Force or any other United States of America Federal Agency.

THE INFLUENCE OF SOLAR ACTIVITY AND GEOMAGNETIC STORMS ON HUMAN HEALTH AND FUNCTIONING

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The work presents interdisciplinary complex investigations of helio-geophysical factors (HGF) influence on the environment, human and society, on health state and reliability of professional functioning of a human in technogenic and social systems of extreme risk. The investigations were performed on a social-population, organismal, organ, cellular and molecular levels. A complex survey of synergistic HGF – influence on human health and functioning of both man and society (including aircraft) was carried out.

The statistical material observed in the work revealed human groups and states of organism mostly labile to depressing or euphory-stimulating effect of HGF together with the HGF- sensitive processes and parameters. To optimize adaptation and prevent the negative impact of HGF we should recommend a complex of physical, psycho-physiological function training methods and medicine.

A number of works have been performed to analyze the centuries-old periods of the active Sun and its influence on the development of historical processes. The synergistic impact of geophysical and cosmophysical factors on the processes of social development and human health state have been studied too in megapolises and geodynamic zones.

The synergistic effect of HGF in time and space within active geomagnetic zones can be traced in both the passionar flows of ancient civilizations (according to L.N.Gumilyov) and macrodynamics of development of modern megapolises, genotypic expansion of intellectually advanced social groups and generation of euristic ideas and geniuses. It was shown that social-population streaming of people according to the depressive and euphory-stimulating effect of HGF may provoke social strain and conflicts accelerating during the periods of the active Sun.

The work was supported by Russian Humanitarian Scietific Foundation (grants No.99-06-00268 and No. 02-06-00251)

INTERNATIONAL EMF PROJECT: RESULTS AND UPDATE ON ACTIVITIES

Repacholi M.

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(The abstract is not present)

2. THE MECHANISMS OF BIOLOGICAL EMF EXPOSURE

PHYSICO-CHEMICAL MECHANISM IN THE ACTION OF WEAK EXTREMELY LOW-FREQUENCY EMF ON LIVE ORGANISMS

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A physico-chemical mechanism for the action of weak extremely low-frequency EMF on cellular processes is suggested and experimentally verified. This mechanism explains the main features of EMF action on organisms, including sensitivity to geomagnetic fluctuations and the diminishing of effects with increasing field strength. A large effectiveness of weak EMF is due to nonstationary processes occurring in heterogeneous medium of cell when ions, experiencing EMF induced by external field, move over the oscillation period to a part of intermembrane distance. Nonlinear effects of ion movement affect the ionic strength and pH near the membrane causing the transitions of peripheral proteins to the water phase, that elevates the number of freedom degrees for protein group movements and is associated with a slight change in free energy. When the fields of higher strength are applied, the voltage, induced by an external EMF, would be confined to the membranes and would only affect the membrane noise level. Experiments dealt with the action of EMF on wheat seeds at different stages of germination confirmed the main points of the mechanism suggested. We observed the release of esterases and pH changes after EMF treatment of seeds at the first day of imbibition. We observed stimulation of root formation when seeds were treated by EMF at an appropriate stage of germination, whereas the same treatment at a later stage stimulated shoot growth only. The results are interpreted as due to EMF effects on the release of proteins affecting these stages in the genetically programmed seed germination. Continuous treatment with EMF during several days of imbibition caused suppression of seedling growth and even the decrease in seed germinability. The decrease in germinability was twofold for seeds showing initial low germinability. These results were explained on the basis that processes, occurring during germination, are associated both with assembling and disassembling of complex structures. The EMF treatment apparently stimulates one of these phases and inhibits the other phase, causing desynchronization of these processes, with the arrest of germination as a limiting case. Hence, biological effects of EMF can be related to both stimulation

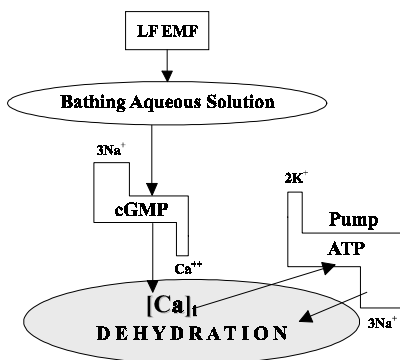
and disruption of the normal course of metabolic processes. They depend on physiological state of an organism, as well as on duration of field treatment, and may cause profound functional disturbances, particularly in the case of preexisting physiological anomalies.

ON THE MECHANISM OF LOW FREQUENCY ELECTROMAGNETIC FIELD (LF EMF) INDUCED CELL DEHYDRATION

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The biological effect of LF EMF effect depends on the initial physiological state and physical parameters of cell or organism, as well as on the characteristics of EMF and other environmental factors. It was shown that cell hydration characterizes cell initial functional state and can serve as a common target for various environmental factors (Ayrapetyan 1998).



As Na–K pump and Na:Ca exchange play important role in metabolic regulation of cell hydration (Ayrapetyan & Suleymanian, 1979), the effect of LF EMF on these mechanisms was studied in snail neurons and heart muscles. It was documented that LF EMF has frequency dependent (most pronounced at 4Hz) activation effect on electrogenic Na–K pump and Na:Ca exchange (3 Na influx and 1 Ca efflux). This effect was accompanied by cell dehydration. More detailed investigation of the mechanism of LF EMF effect on the mentioned ion-transporting systems and cell dehydration allowed us to suggest that EMF induced water structure changes activate guanylatecyclase

(production of cGMP) switching on the following metabolic cascade (schematically presented below): cGMP dependent Na:Ca exchange activation – decrease of intracellular Ca – activation of Na–K pump – cell dehydration. .

MOLECULAR GYROSCOPES AND KT-PROBLEM IN MAGNETO-BIOLOGY

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The mechanism based on the interference of ion quantum states within the protein cavity predicts variety of complicated dependences of biological responses on electromagnetic field parameters [Binh VN. Magnetobiology. Academic Press, San Diego, 2002]. In many cases they match nicely experimental observations [Binh VN, Goldman R. Biochim Biophys Acta 2000, 1474:147]. However, the mechanism postulates that the thermalization time of an ion inside the cavity exceeds Ω^{-1} , where Ω is the ELF MF frequency. Here a biophysical mechanism is proposed that (i) retains the attractive features of the ion interference mechanism, i.e., predicts physical characteristics that might be experimentally examined and (ii) uses the principles of gyroscopic motion and removes the necessity to postulate large lifetimes. The mechanism considers dynamics of the density matrix of the molecular groups, which are attached to the walls of protein cavities by two covalent bonds, i.e., molecular gyroscopes [Binh VN, Savin AV. Phys Rev E, 65, 051912, 2002]. Numerical computations show almost free rotations of the molecular gyros. Of importance is the fact that thermal oscillations of the gyroscope's seats make only zero torque about the axis of rotation. This leads to relatively slow thermalization of a gyroscopic degree of freedom. Probably, ensembles of a few protein globules or DNA/RNA processes form such cavities between them. For example, amino acid molecules might be built in such cavities, organizing two chemical bonds at distant ends of the molecule, third polar group being free to interact chemically with a special active site on the inner wall surface. At more or less general assumptions predicted frequency and amplitude spectra have the form similar to the case of the ion interference. The main properties of the gyro interference are identical with those of the ion interference, namely, (i) multiple peaks in the amplitude and frequency spectra, (ii) dependence of the positions of frequency peaks on the DC MF intensity, and (iii) independence of the positions of amplitude

maxima on the AC MF frequency. The model also provides 'windowed' spectra of sensitivity to electromagnetic fields in the microwave range. There is the crucial feature of the gyro interference: molecular gyros are relatively immune to thermal shaking and may be effective biophysical targets for external MFs. Thus, today, that model is a unique one to fix the kT-problem in magnetobiology.

MECHANISM AND INTERFERENCE OF GAP-JUNCTION INTERCELLULAR COMMUNICATION SUPPRESSION INDUCED BY ELF MAGNETIC FIELD

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Gap junction intercellular communication (GJIC) plays an essential role in regulation of cell growth, proliferation, and differentiation. We have previously demonstrated that effects of 50 Hz MFs on GJIC are dependent on the exposure intensity and duration. Exposure to 0.4 or 0.8mT for 1–24 h can inhibit GJIC; 0.2 mT do not suppress GJIC, but can enhance the GJIC inhibition by TPA.

The mechanism of GJIC suppression by ELF MF was studied: (1). NIH3T3 and CHL cells were exposed to 0.8mT 50 Hz MF for 24 h. The transcription levels of connexin43 gene in these exposed cells were examined by Northern blot analysis. No significant difference was observed as compared to control. (2). The changes in connexin43 and the degree of Cx43 phosphorylation after treatment of NIH3T3 cells with 24 h, 50 Hz, 0.8 mT and/or 2 h, 3 ng/ml TPA were examined by Western blot analysis. The results showed that the ELF MF and/or TPA exposure induced a decrease in non-phosphorylated Cx43 (P_0). Meanwhile cells treated with the ELF MF and/or TPA displayed a hyperphosphorylated Cx43 band (P_3). Similar changes of P_0 and P_3 were observed in membrane fraction or in the cells' total protein, and the results showed that Cx43 protein level did not appear to be substantially altered by any of the treatments. (3). To explore if PKC is involved in the connexin43 hyperphosphorylation, an experiment with PKC inhibitor stawosporine (STS) or palmitoyl carnitina (PMC) was carried out. CHL cells were exposed to 50 Hz 0.8 mT MF for 24 hours and combined with PKC inhibitor (STS or PMC) at different concentrations during the last one-hour. The results showed that the suppression of GJIC induced by ELF MF was

dramatically inhibited in the presence of 10 nM STS or 10 μ M PMC. (4). To study the effect on the localization of the Cx43, CHL cells were exposed to 0.8 mT, 50 Hz MF for 24 h, and/or 5 ng/ml TPA for 1 h. The results showed that many gap junction plaques were bright labeling at regions of intercellular contact in control cells. The treated cells, either with ELF MF or with TPA, displayed an entirely different pattern: with less and punctuate labeling, and a large part of them appear in the cytoplasm and nuclear area of the cells. Internalization of Cx43 proteins was observed in exposed cells. In summary, the mechanisms of suppression GJIC by ELF MF is at the post translation level: due to hyperphosphorylation of gap junctional connexins mediated by PKC, and the aberrant localization of Cx43

Litovitz reported that the presence of noise MF, comparable in magnitude to the MF signal, could nullify the MF bioeffects. We studied the effect of superposition of an noise MF on GJIC suppression induced by 0.4 mT 50 Hz MF. The results showed that the noise MF with the same intensity of 50 Hz MF can block the suppression induced by 0.4 mT 50 Hz MF. The results demonstrated that incoherent noise MF could inhibit the bioeffects produced by coherent MF.

MATHEMATICAL MODELLING IODINATION OF COLLOID AMINO ACIDS OF THE THYROID GLAND UNDER THE INFLUENCE OF THE ELECTROMAGNETIC FACTOR

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In the experiment on white nonpedigree male rats the ability of mathematical modeling and the forecast of the effect after EMR single separate (2.4 ГГц, 10 мВ/см², of exposition 2.5 min) on hormonopoietic in the thyroid gland (TG), based on an estimate follicle relation, containing iodinated (IA), partially iodinated (PIA) and non iodinated amino acids (NI) of colloid was studied. The material was researched through 1.7, 5, 24 and 72 hours after the termination of an exposure. The value of the link between IA, PIA and NI was determined with the help of pair correlation. The predictions applied to mathematical modelling and the forecast had adapted the multiple regression analysis (MPA), interpreted with the usage of criterion Darbin-Watson and a percentage error of approximating.

It was established, that through 1.7 h after the EMR effect, as well as for intact animals, judging by MPA, some well enough expressed and equivalent links between IA, PIA and NI are saved. However an electromagnetic factor (Em-factor) causes a lowering level of correlation between IA and NI, PIA and NI. 5 h later the coefficients of the MPA equation to NI were essentially increased, that was accompanied by restoring of the initial metrics of correlation. Through 24 h the main dependences between IA and PI or NI do not differ from the control. After 72 hours the IA concentration dependence from the PIA and NI contents are sharply reducing. At the same time only between IA and PIA there appears a strong negative link: $p = -0.9$.

Thus, the mathematical model of hormonopoietic in TG after the EM-factor single effect has a certain character and testifies to a phase character of dependence in the contents of colloid iodinated, not iodinated and partially iodinated amino acids.

BIOLOGICAL EFFECTS OF MAGNETIC AND ELECTROMAGNETIC FIELDS: PRIMARY PROCESSES AND MECHANISMS.

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(The abstract is not present)

ELECTROMAGNETIC RADIATION OF CYCLIC ORGANIC SUBSTANCES: MECHANISMS OF GENERATION AND BIOLOGICAL ACTION

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We experimentally determined that hermetically sealed organic substances with aromatic nature (containing benzolic rings or heterocycles) exert non-Contact (in the distance) influence upon the enzyme activity, daphnies and infusories locomotoric function, alcohol fermentation activity, germination rates of pea seeds, fertility and life duration of daphnies, drosophyles embryo development etc. It was showed that these substances generate electromagnetic radiation (EMR) of centimeter range. The benzolic rings and het-

erocycles possess the property of superconductivity in respect to cyclic current of p-electrons that transform the molecules with aromatic nature to elementary magnets. The latter orientate along the force lines of geo-magnet field (GMF). The chaos motion of surrounding molecules leads them out of the equilibrium state, whereas the return to it comes by the oscillation movement accompanied by the EMR generation. The molecular mechanism of EMR generation corresponds to molecular mechanism of its absorption by resonance oscillations of macromolecules containing benzolic rings and heterocycles (proteins, nucleic acids etc.) and oriented in GMF. In enzyme molecules the absorbed energy spends to the reverse conformation changes. Probably the EMR generated by biomolecules like the optic range radiation (Gurvich, Kaznacheyev) takes part in the exchange of information between the cells in multi-cellular organism. The wide non-controlled use of substances containing benzolic rings in industry and life together with the widespread of technical sources of centimeter range waves creates the hindrances in the work of intercellular information channel leading to the negative consequences for the organism. Likely the magnet storms the artificial change of magnet field tension in environment also violates the work of this channel.

MODEL AND EXPERIMENTAL ANALYSIS OF ABSORPTION OF EXTREMELY HIGH-FREQUENCY ELECTROMAGNETIC RADIATION IN THE SKIN OF LABORATORY ANIMALS

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The correct planning and conducting experiments on studying biological effects of electromagnetic fields is impossible without knowing of peculiarities and methods of dosimetry. In spite of application of different methodical means to prevent distortion of electromagnetic field distribution in exposed objects, an actual energy absorption by the object always measurably differs from that calculated theoretically. Using experimental and theoretical methods of dosimetry, we have analyzed energy absorption of extremely high-frequency electromagnetic radiation (EHF EMR) in the skin of laboratory animals. Specific absorption rate (SAR) in the skin was determined on the basis of both microthermometric measurements of initial rates of temperature rise in rat skin induced by exposure and microcalorimetric measurements of

specific heat of the skin. Theoretical calculations of SAR in the skin were performed taking into account dielectric parameters of rat skin obtained from standing wave ratio measurements at reflection of electromagnetic waves from the skin surface and considering effective area of stationary overheating measured by a method of infrared thermography. The numerical method was developed to determine electromagnetic wave energy reflected, absorbed and transmitted in the model of flat layers. An algorithm of the method was realized in computer program and used to calculate SAR in the skin on the basis of complex dielectric constant of rat skin. The SAR values obtained from experimental measurements, theoretical calculations and numerical analysis are in good mutual correspondence. The results obtained can be used for dosimetric supply of biomedical experiments on studying physicochemical mechanisms of EHF EMR biological effects.

THE BIOPHYSICAL WAYS AND MECHANISMS OF MICROWAVE ACTION

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Microwave heat effect has been studied and put into practice by native and foreign researchers. Its main mechanism consists in turning electromagnetic energy into a heat one and temperature rising of the radiated object. Therefore a heat effect is observed when radioemission of comparatively high intensity (more then 10 mW/cm^2) is in action. Microwave object heating has certain advantages: a necessary section of the radiated system can be heated and the heating can be quick and even all over its volume.

At the same time microwaves have another specific action, which is often decisive. This specific action does not depend on possible system heating and involves microwaves selective action on biomembranes and other highly organized molecular and super molecular systems of living cells and the whole organism. Such an action is caused by synchronization and perhaps by resonant effects.

In previous researches we reported that on a molecular level a specific action was determined when investigating two reactions of

complexformations under microwaves influence. They are complexformation reaction in the system of organic reagent pyridilazoresorcin (PAR) with aqua complex CrCl_3 and oxygenation of donor's undiluted stabilized blood (the formation of molecular oxygen complex with hemoglobin).

Microwaves influence on reactions and processes of complexformation is mainly caused by molecules of structured aqua and OH-groups of corresponding molecules and their systems.

In present work we investigated the importance of aqua in the mechanisms of EMF and EMR action on the viability of organisms. Thus the experimental research revealed that the energy of growth and a subsequent development of wheat are activated by microwaves in 1667 MHz range, the humidity of growing grains being of some importance. This way of plants growth which includes their microwave stimulation and aqua participation is in full accordance with our previous theoretical and experimental data on molecular mechanisms of microwave biophysical action.

THE FUNDAMENTAL CONUNDRUM: WHAT IS THE INITIAL PHYSICAL MECHANISM BY WHICH NON-IONIZING, EXTREMELY LOW FREQUENCY ELECTROMAGNETIC FIELDS INFLUENCE BIOSYSTEMS?

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Objective: We seek to answer the conundrum: What is the fundamental mechanism by which very weak, extremely low frequency EM fields influence biosystems? In considering the hydrophobicity of intramembranous protein (IMP) H-bonds which cross the phospholipid bilayer of plasma membranes, and the necessity for photonic recycling in cell surface interactions after dissipation of energetic states, present models lack structure and thermodynamic properties to maintain ΔE sufficient energy sources

necessary for amplification by factors of 10^{12} . Even though one accepts that the ligand receptor association alters the conformation of extracellular, extruding portions of IMP's at the cell surface, and that this change can be transmitted to the cytoplasm by the transmembranous helical segments through nonlinear vibrations of proteins with generation of soliton waves, one is still unable to account for repair and balanced function. Indeed coherent responses of critical molecules to certain picoTesla range magnetic field signals of extremely low frequency may include enhanced vibrational amplitudes, increased quanta of thermal energies and order inducing interactions.

Method: We may accept that microtrabecular reticulum-receptor connections consist of acting filaments and ATP molecules which contribute to the activation of the cyclase enzyme filaments and ATP molecules which contribute to the activation of the cyclase enzyme system through piezoelectricity. Magnetic fields will pass through the membrane, which sharply attenuates the electric field component of an EM field, due to its high impedance. Furthermore, EM oscillations are converted to mechanical vibrations secondary to resonant amplitudes and frequencies specifically responsible for bioamplifications of weak triggers at the membrane surface, as well as GAP junctions.

The hydrogen bonds of considerable importance are those in proteins (10^{12} Hz) and DNA (10^{11} Hz) and may be viewed as centers of EM radiation emission in the range from the mm microwaves to the far IR. However, classical electrodynamical theory does not yield a model for biomolecular resonant responses which are integrated over time and account for the connection between the phonon field and photons. Jacobson Resonance does supply an initial, physical mechanism, as equivalencies in energy to that of Zeeman Resonance (i.e. zero-order magnetic resonance) and cyclotron resonance may be derived from the DeBroglie wave- particle equation. For the first time, we view the introduction of Relativity Theory to biology in the expression $mc^2 = BvLq$, where m is the mass of a particle in the "box" or "string" (molecule in a biosystem) B is the magnetic flux density, c is the velocity of electromagnetic field in space, independent of its inertial frame of reference, q represents a unit charge, $q=1$ ab-coulomb, by defining electromotive force as energy per unit charge, v is the velocity of the carrier or "string" (a one or two dimensional "box") in which the particle exists, and L is its dimension (length).

Conclusion: The equivalencies or resonant energetic states suggest that the $qvBL$ is one of the fundamental expressions of energy of a charged wave-particle in magnetic fields, just as the Zeeman Resonance and cyclotron

resonance energy expressions, $g\beta B$ and $q\hbar B/2\pi m$, and is applicable to all charged particles in boxes (molecules in biological systems). Thus, there exist spontaneous, independent and incessant interactions of magnetic vector B and the elementary charged “particle-in-a-box” which exert Lorentz forces upon the quantum vacuum. The Lorentz force is transmitted from EM field to gravitational field as a gravity wave, which returns to the phonon field as microgravitational fluctuations to therein produce quantum vibrational states that increase quanta of thermal energies integrated over time. This accounts for the differential of 10^{12} between photonic energy of an ELF wave and the Boltzman energy kT . Recent data from in-vitro and in-vivo studies are included as empirical support for the hypothesis presented.

DISSIPATIVE RESONANCE IS A NEW CLASS OF SELF-ORGANIZATION PHENOMENA IN THE SYSTEMS OF DIFFERENT NATURE

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We have given the definition of dissipative resonance at 1997 with the aim to solve the “ kT problem” taking place in the models of biological object on exposure to weak electromagnetic fields (EMF). More detailed analysis of this phenomenon gives that the dissipative resonance may occur in the systems of different nature. So we face a new important class of self- organization effects. To realize this phenomenon it is necessary to exist the receptors of EMF on one hand and the visco-elastic medium in which a slow drift of the receptors is possible on the other hand.

The dissipative resonance includes three basic processes: the first is the interaction of the receptors with the external field; the second is the appearance of steady-state oscillation in the visco- elastic medium by interaction between the particles of it and the receptors; and, at last, the third is the directed drift of the receptors along the medium. Under certain conditions the drift may result in the formation of a phase lattice (a structure of order) that is followed by the increase of medium oscillation amplitude and leads to the appearance of the effects observed. So the “ kT problem” may be solved by the integrating properties of visco-elastic medium.

The receptors of external field can be both simple objects such as ions, electric or magnetic dipoles (in the case than electromagnetic field), massive particles (in the case than acoustic field) and compound objects like ion-

protein complex and others. The role of visco-elastic medium can play three-dimensional colloid liquids, two-dimensional membranes or one-dimensional structures.

As the receptors we can consider an objects having self-oscillation properties. In this case we face a concept of self-oscillation dissipative resonance. In general case the oscillation process has no mechanical nature but there is an oscillation of changing any kind of medium parameters. Here, apparently, it is reasonable to introduce a new term as the structural-dissipative resonance.

MODELLING OF ELECTRIC POTENTIAL BAND FORMATION ALONG THE CELL MEMBRANE

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The physiological role of some electric phenomena such as propagation of nerve impulse, oscillations of membrane potential is well studied. But there are some processes that have no clear physiological sense. In particular, the consequence is an asymmetric pH distribution along plasmalemma of green alga *Chara* and *Nitella* that is responsible for ions currents between “alkaline” and “acid” bands and Ca^{2+} currents between the apical and rhizoid poles of *Fucus* zygote. Apparently such distributions can play some role in morphogenesis.

The purpose of this work is to propose the mechanism of such non-uniform potential distribution considering as an example cell membrane of algae *Chara*.

To construct the model we used partial differential equations, describing the system dynamics in time and in space. We supposed that considering nonlinear processes are connected with acting of proton ATPase and proton channels, providing active transport and passive transport. Offered mechanism is based on positive feed-back loop between proton flux and transmembrane potential. It is supposed that the band formation takes place due to nonlinear character of ion fluxes across the membrane. We obtain equations for proton concentration changes on the external side of the membrane in accordance to ATPase kinetic scheme. The proton transfer constants depend on the membrane potential. The total membrane current was consisted of the capac-

ity current and ionic current. Ionic current was consisted of ATPase ionic current and leak current. The last includes all the other ionic fluxes.

Analytical and numerical study of the above system showed the existence of the oscillative regimes damped and undamped at the certain parameters of the system, that in agreement with the experimental data. Having studied the reaction-diffusion system we found dissipative structures at some values of parameters. The model adequately describes the threshold character of banding formation of transmembrane potential and pH, depending of this of light intensity and ionic composition of media.

SELF-CONSISTENT ELECTRIC FIELD CONTRIBUTION IN SPATIO-TEMPORAL DYNAMICS OF CHARGED MOLECULES IN NEAR MEMBRANE LAYER OF CELL

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Most of physiological processes on the cell level are conditioned on interaction of charged molecules. This fact determines the necessity to allow for the contribution of self-consistent electric field (the field appearing due to moving and interaction of charged particles) in modeling of dynamics of cell membrane processes. The analysis of mechanisms of such processes demands the studying of the spatio-temporal regimes induced by self-consistent electric field and such models must contain reaction-electro-diffusion equations. Usually such systems are considered under approximation of local electro-neutrality it is not valid for such biological systems as cell membrane and near membrane layers.

We want to show on the simple model that taking into account self-consistent field contribution in the system with nonlinear chemical kinetics can give rise to electric potential redistribution and arising of potential gradients in near membrane layer. We considered electro diffusion equations for positively and negatively charged ions. The Brusselyator equations were used as a nonlinear model to describe chemical interaction. The approximation of local electro-neutrality was used for steady state only. This system becomes bistable within a certain domain of parameters. The steady state with uncompensated charges results in potential gradient arising in near membrane layer. Such gradient can serve as an additional moving force for fluxes of sub-

stances towards the cell. We found that the influence of self-consistent electric field changes the conditions of Turing instability. New spatio-temporal regimes like sole waves and irregular dynamics can arise. By studying the system in the domain of bistability the step-like distribution of ions was found. This step-like ion distribution combines two steady states. The large potential gradient exists within the narrow region of the step-like ion distribution membrane.

Thus, the influence of self-consistent electric field on bistable systems can lead to the ion redistribution between two stable steady states and to the rise of large potential gradient along the cell membrane.

MULTI- PARTICLE MODEL DESCRIBING THE MECHANISM OF INITIAL EMF ABSORPTION BY BIOLOGICAL OBJECTS. SOLVING THE “KT PROBLEM”

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Now it is supposed that weak electromagnetic field (EMF) can change the probability of ion- protein complex dissociation in the cell. The frequency dependence of effects caused by EMF has a sharp- resonance shape. In literature a number of one- particle models describing the dependence of complex dissociation probability on frequency of EMF is presented. However, all of these models leave out of account the temperature noise of the medium. In weak EMF the energy of an individual ion due to the external field is far smaller than the energy due to the stochastic motion of molecules surrounding the ion considered. Therefore the energy of the external field dissipates faster than the complex can dissociate. This problem that has been called “kT problem” cannot be settled by any one- particle model but it could be solved by assuming of certain collective interaction of the external field with a great number of particles of the same type. In this case the external action would promote formation of space- ordered structure in which the particles create a cluster in phase space. The motion of the particles is similar to a motion of one particle with a great mass and charge. As a result, the total energy of the particles involved at their sufficient quantity may overlap or exceeds the temperature noise.

The model presented is the set of one- particle excitations interacting with each other by visco- elastic medium they are located in. The particle energy dissipation is taken into account by viscous. In such a system on expo-

sure to external periodic force the self- organization is possible. This phenomenon results in the increase of the model system energy proportionally to the number of particles involved in the process. We have called this effect as dissipative resonance. The frequency dependence of the model system energy has qualitative similarity with the one experimentally observed.

ACCEPTIVE APPARATUS OF BLOOD FOR ELECTROMAGNETIC RADIATION OF VISIBLE AND INFRARED DIAPASON

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In the work there was attempt of the integration of available and new data for creation of the whole notion about triggers of photomodification of the blood on the information about spectral characteristics (in the diaposon wave lengths from 300 till 1400 nm) of the whole blood and its component obtained before and after the influence of low energetic electromagnetic radiation of visible and infrared diaposon. The assumption about dependence of the membrane properties from phenomenon of dimerisation and agregation of porphyrinic structures was confirmed by the results of coefficient dimention of eximerisation of fluorescentic pyrene probe.

The processes of blood photomodification are stated to be universal mechanism of the bioobject responce including bicontour scheme of alteration in the condition of buffer system of peroxide oxidation and antioxidative defence. Antioxidative contour is stimulated by means of photoinduced reactivation of glutathione peroxidase and cytochrome oxidase complex of the membrane cell structures. In addition to it there is some porphyrin dedimiri-sation (including metalcontaining porphyrins) determined by photoaction and reactivation of a number of antioxidant ferments of lipoid and water phase. The launching of prooxidant contour of response takes place at the expense of photodynamic effect (direct stimulation of membrane complex of photoporphyrin and hematoporphyrin with participation of O₂). Moreover the absorption of infrared diaposon of spectrum may be transmitted to the oxygen molecules by means of relaxation of stimulative energy of the mentioned sub-strata. It may launch the total chain of peroxide lipoid oxidation.

It was stated that effects of dimerisation and aggregation of porphyrin (including metalcontaining) are derivative of “the getting old” of membrane cell structures (model medium is erythrocyte and its washed membrane). It

directly depends on specification and expression of the pathological process realized into concrete nosology in the organism.

**FREQUENCY AND AMPLITUDE WINDOWS AT THE ACTION
OF ALTERNATING MAGNETIC FIELD SEPARATELY
AND IN COMBINATION WITH CONSTANT MAGNETIC FIELD**

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We derived the differential equation describing action of DC and AC magnetic fields on thermal motion of ions on a biological macromolecule. The solution of this equation showed arising multiple of new resonance peaks in ion thermal oscillations at the action of the above fields. After the establishment of new equilibrium in the deep of the macromolecule in conditions shielding from the action of small molecules of the medium surrounding the macromolecule, the change in energy of ion thermal motion is occurred quite sufficient for changing conformational state of the macromolecule. On this basis a diversity of medico-biological phenomena can be explained including known “frequency” and “amplitude” windows without invoking physically unjustified in these conditions effects of “cyclotron” and “parametric” resonances. It was made an attempt to understand the reasons of weak reproducibility of results of the experiments with magnetic fields.

3. SOMATIC EFFECTS OF EMF EXPOSURE

MORPHOFUNCTIONAL CHANGES IN DIFFERENT SECTIONS OF CENTRAL SYSTEM IN THE EFFECT OF ELECTROMAGNETIC FIELD

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The aim of the study is the evaluation of central nervous system neuronal changes in the effect of 6 hours electromagnetic field exposition (EFE) during 30 days (frequency 50 Hz, induction 0.1 mTl, duration of impulses 10^{-2} sec). Morphofunctional reaction of nervous and glial cells was studied in III–IV, V strata of sensorimotor cortex in rats.

The assessment of adaptive reactions in restitutional period (after 1 and 30 days of exposition) is given. In the effect of EFE the morphological status was characterised by the presence of neurons with ion coloured cytoplasm, increase of neuronal and nucleolar volumes and perineuronal index. Morphological changes were mostly expressed in 3–4 strata of sensorimotor cortex.

After one day EFE hypochronic neuronal reaction remained; morphometric indices were top the control. Considerable changes were marked in 3–4 strata of sensorimotor cortex.

After 30 days EFE no morphological differences with control were detected. Perineuronal index was insignificantly increased.

The effect of long-term EFE is determined by some changes in sensorimotor cortex neurons's proteosynthetic processes which normalize in about 30 days not without active participation of glia. Neurons of 3–4 sensorimotor cortex strata revealed the most lability.

The received data indicate a non-specific neuronal reaction of sensorimotor cortex which develops in the effect of environmental factors as an adaptive physiologically determined protective reaction.

THE BIOLOGICAL EFFECTS OF THE WEAK NONIONISATION ELECTROMAGNETIC FIELDS ON FISHES *CARASSIUS AURATUS* IN VIVO

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A motion activity depression for *Cyprinidae* fishes has been detected during geomagnetic storms in laboratory environment. The simulative experiments with the weak magnetic fields of 5 - 200 nT in 0.1 - 10 Hz frequency range have shown that hydrobionts lose their stability and no adaptation can be observed [4th EBEA Congr, Proceedings, Zagreb, 1998, p.103, 5th EBEA Congr, Proceedings, Helsinki, 2001, p.237-239,].

At present we study the behavior physiology of a new variety population of the *Carassius Auratus Japonicus Flabellicaudatus*, Slutsky, 1985 goldfish. We cultivate it since 1970 by closely-related interbreeding of the organisms having common ancestors (strict inbreeding). These fish's behavior after the exposition to electromagnetic fields of various intensity and frequency was studied.

Influence of fixed induction weak EMF in a different frequency range.

Total features of induction influence $\Delta B = 200$ nT:

- depressing of fish activity is expressed in abrupt falling of spectrum **G(f)** energy;
- fluctuations $\Delta\phi$ energy lowering within frequency band more than 1 Hz;
- low frequency part of a spectrum before and after influence is characterized by an exponent $n \approx 1/2$.
- at a general indicator of fish activity depressing the weakly intensifying frequency 1 Hz is noticeable, at which the greatest level of **G(f)** energy spectrum is preserved; and on frequencies 3, 4, 7 and 10 Hz the level is reduced as much as 10 times and even more accordingly;

• after effect 3, 4, 7 and 10 Hz shifted to lower range (0.01 ÷ 0.1 Hz);
Influence of fixed frequency weak EMF at different levels of magnetic induction

- the period of exposure is characterized by sharp falling in energy at $\Delta B = 200$ nT precisely within the limits of 0.01 ÷ 0.2 Hz, and for $\Delta B = 500$ nT and $\Delta B = 1000$ nT is expanded up to frequency 0.4 Hz;

- After the influence the fish (during the term of observation) do not return in an original state, especially within the limits of first 0.5 Hz, and further distinctions in spectra $G(f)$ get smoothed out.

THE EFFECT OF DISTILLED WATER TREATED BY LOW FREQUENCY ELECTROMAGNETIC FIELD (LF EMF) ON THE PROCESS OF SPRING WHEAT ROOT FORMATION

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Previously it was shown that LF EMF has frequency dependent effect on the specific electrical conductivity (SEC) of distilled water (DW) and water solutions, as well as on the growth and division of *E.Coli K-12* Lon mutant. The purpose of the present work was to check the effect of DW, treated by 2.5 mT intensity EMF at 4, 10, 15, 20, 50 Hz frequencies for 30 minutes, on root forming of wheat. Experiments were performed in Petrie's dishes (45 seeds in each), containing paper-filters at 18° C in dark conditions for the first 9 days and in normal light conditions for the rest 5 days. Samples were poured up every 48 hours with 10ml DW treated by LF EMF. A generator of sine-wave with special coil producing 2.5 mT EMF was used for EMF-treatment. In darkness 4, 10, 15, 20, 50 Hz EMF-treated DW had depressing effect on root forming process by –7.06%, –2.10%, –7.06%, –49% and –54% accordingly, while in light conditions this process was activated – at 4, 10 and 15 Hz frequencies the root growth prevailed by +1.71%, +5.5% and +4.67% accordingly compared with control. It is interesting to note that at 20 and 50 Hz treatment EMF had depressing effect by –24% and –65% accordingly in light, like as in dark condition. The obtained data clearly demonstrate that LF EMF-induced frequency dependent effect on physicochemical properties of water has modulation effect on the process of wheat root forming, and that these effects have opposite direction in dark and light conditions at 4, 10 and 15 Hz. These allow us to suggest that 4–15 Hz frequency “windows”-induced water structure changes have activation effect on the process of photosynthesis.

**MORPHOFUNCTIONAL STATE OF MAGNOCELLULAR
NUCLEI OF HYPOTHALAMUS IN CONDITION
OF RADIOMODIFICATION OF ELECTROMAGNETIC
RADIATION BY CHANGED GASEOUS MEDIUM**

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In experiment on white male outbred rats the effects of separate and combined application of electromagnetic radiation (EMR) of a microwave-range (2.4 GHz, 10 mW/cm², 2.5 minutes), hypoxic gas mixture (HGM), containing 8% O₂ and 92% N₂ and normobaric oxygen (NO) on the morpho-functional state of magnocellular nuclei of hypothalamus (MNH): supraoptical (SON) and paraventricular (PVN), were studied. On the frontal paraffin sections colored with paraldehyde-fuchsin on Gomory technique, the relative content of types of neurosecretory cells (NSC) on classification of A.L. Polenov's classification (1993) was determined. The material was analyzed after 1.7, 5, 24 and 72 hours after exposures.

At combination EMR and NO through 1.7 h in both NSC there was more expressed, as contrasted to exposure of the electromagnetic factor (EM-factor), an increase of the amount of NSC of "superactivity" state (1A type) and decrease of NSC number in state of "moderate activity", saved up to the end of the experiment, specially, in PVN. The shared usage of EMR and HGM after 1.7 h and less, after 5 h, resulted in rising of a content of deposited NSC (1B type) and complete absence of a Gomory-positive substance in axons of secretory neurons. To 24 and 72 h in MNH the increase of number NSC of 1A type, in main was found out, at the expense of decrease of the amount NSC of 1B type.

Thus, the effects of radiomodification of the EM-factor by a changed gaseous medium on MNH are determined by the concentration of oxygen: NO provokes the activation of neurosecretory activity MNH, whereas HGM causes expressed, but reversible depressing of derivation of secretory granules.

CHRONIC EXPOSURE OF INCOHERENT ELECTROMAGNETIC WAVES OF MILLIMETER RANGE ON THE ORGANISM

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The aim of the research was to study the effect of incoherent (noise) electromagnetic waves (EMWs) of mm-range on some structure-functional properties of erythrocyte membranes and the chromosome apparatus of bone marrow cells (BMCs) of white inbred rats exposed to chronic irradiation.

As the source of incoherent EMWs we used “Artsakh-2” device with the density of falling current of 50mW/cm^2 and radiation frequency of 40–90 GHz.

The animals were exposed to total irradiation during 30 minutes for a period of 4 days. On day 7, 14, and 30 post the chronic irradiation the following was studied: lipid peroxidation (LP) products level, erythrocyte deformity, permeability for K^+ ions and the membrane potential of peripheral blood erythrocytes in animals. The state of chromosome apparatus of BMCs was studied by the end of observation term (day 30).

The results obtained signify that the effects of mm-range EMWs registered according to the above-mentioned indices are revealed at both early and delayed periods post radiation. The significant increase on the activity of LP, decrease of erythrocyte deformity, disorder of ion-transport properties of erythrocyte membranes were stated. It was revealed that mm-range incoherent EMWs produce the mutagenic effect and cause stable cytogenetic changes of BMCs of radiation-exposed animals: the increase of chromosome aberrations frequency and expressed cytopenia, – the decrease of number of proliferating cells.

OF QUANTITATIVE DISTURBANCES IN CEREBELLAR STRATUM ORGANIZATION EFFECTED BY PULSE ELECTROMAGNETIC FIELD (PEMF)

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The experiment was performed on rats, trained during 5, 7, and 10-month period by wide-band high-amplitude pulses of ultra-short duration (15–40 ns)

and the induced current density (ICD) – 0.37; 0.70; 2.70 kA/m² at pulse regime (PR) of 500; 100 and 50 pulse/week.

Under PEMF influence with ICD $\approx$ 0.37 kA/m² at PR = 500 and 100 pulse/week there is no statistically significant changes in the of neurons density arrangement. At the same time the decrease of PR to 50 pulse/week causes statistically reliable reduction of neurons quantity on the area unit of molecular stratum up to 84.6%, 74.4%; 67.9% (in % terms of the initial level), corresponding to 5–7 and 10-month period influence. The PEMF effect with ICD = 0.70 kA/m² causes morphological shifts of the similar direction in neuron arrangement of molecular stratum. At PR = 500 and 100 pulse/week the neurocytes' quantity decreases to 76.2% and 70.5% at 10-month period influence. At the same time the increase of pulse-to-pulse interval leads to the quantitative data decrease during all the exposure term up to 72.3%, 69.1% and 65.8%. The voltage increase up to 2.70 kA/m² provokes the decrease of neurocytes in molecular stratum by this time in experimental group with the regime of 500 pulse/week at 10-month period of PEMF influence. The most essential quantitative changes occurred in the group with PR = 50 pulse/week: 5-month PEMF influence is followed by the decrease of neurons density arrangement to 61.1%, 7-month influence – to 57.2%, and 10-month influence to 52.9%, i.e. at the given regime practically half of the molecular stratum neuron content underwent cytolysis.

Thus, the expression of neurocytic loss increases with the increase of exposure terms and the increase of pulse-to-pulse interval.

EFFECTS OF ELF AND MICROWAVES ON HUMAN LYMPHOCYTES FROM HYPERSENSITIVE PERSONS

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Hypersensitivity to electromagnetic fields (EMF) is a fairly new phenomenon and etiology of the EMF hypersensitivity is not yet known. Here, we used specific conditions of exposure to extremely low frequency (ELF,

8 Hz, 30 μ T amplitude or 50 Hz, 15 μ T amplitude) EMF and microwaves from real GSM mobile phone (915 MHz, SAR=1–2 mW/g in the TEM-cell) to investigate the response of lymphocytes from hypersensitive persons. The groups of hypersensitive and healthy donors were matched by gender, age and smoking habits and all data were analyzed in blind. The changes in chromatin conformation were measured with the method of anomalous viscosity time dependencies. Apoptosis was determined by morphological changes. Apoptotic fragmentation of DNA was analyzed by pulsed-field gel electrophoresis. 53 bp1 protein, which has been shown to co-localize in foci with DNA double strand breaks, was analyzed by immunostaining. All exposures were 2 h. Exposure either to ELF/50 Hz or GSM microwaves resulted in significant condensation of chromatin, which was comparable with heat shock at 41–42° C. Changes in chromatin condensation correlated with a distinct decrease in 53 bp1 signaling. Exposure to ELF/8 Hz resulted in statistically significant apoptotic DNA fragmentation, but this response disappeared when static magnetic field was changed by 10 μ T. The data suggested that ELF magnetic fields and GSM microwaves under specific conditions of exposure affect lymphocytes from healthy and electrosensitive donors. These effects vary between donors. In some cases, cells from hypersensitive donors responded to ELF/GSM stronger than cells from gender- and age-matched control subjects, but this difference in responses need to be confirmed in a larger study group.

The Swedish Council for Working Life and Social Research and the Swedish Radiation Protection Institute supported these studies.

MEDICAL AND BIOLOGICAL EFFECTS OF SOLAR ACTIVITY INFLUENCE.

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Problems of interaction of heliophysical processes and physical and mental population health parameters is very important for medical and ecological monitoring. It is known that the solar activity influences on human health parameters. In literature sources there are a lot of information about natural EMF fluctuations influences on the different physiological parameters of blood, hormones, arterial pressure. However, the comparative characteristics of different functional systems sensitivity to solar activity wasn't made.

The aim of this research was the determination of heliophysical factors effects on people with different systems diseases. About 65 530 visits of pa-

tients to doctors were studied (at the period 01.01.1999 to 20.10.1999). The next systems disease cases were analyzed: cardiovascular, nervous, endocrine, breathing, alimentary, genitourinary ones. Values of solar activity indexes W (number of solar spots) and $F_{10,7}$ (solar flux density, frequency – 2800 MHz, $\lambda=10,7$ cm) at the same period of time were ranges according their intensity.

The statistical analysis demonstrated, that increasing of solar perturbations attended by increasing of patients suffering from hypertension, epilepsy, diabetes, metabolism dysfunction, renal diseases. Beside this, it was revealed that solar activity fluctuations affected favorably on some pathologies (for example, rhinitis and sinusitis).

The obtained results allow to conclude, that the most negative solar activity effects had people with chronic diseases of cardiovascular, nervous, endocrine, genitourinary systems.

EXPERIMENTAL STUDIES INTO THE INFLUENCE OF ABSORBED ELECTROMAGNETIC ENERGY ON THE BIO-LIQUID STRUCTURE

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For today specific mechanisms of PMF effect on the body are insufficiently studied, so development of individual schemes of treatment encounters certain difficulties, when PMF effect on the body is estimated. To solve this and some other problems of magneto-kinetics an experimental research has been performed on studying bio-system response to PMF, in which the methods of dehydrated bio-liquid structural analysis were used. The bio-liquids (blood serum, urine and albumin solution) were magnetically treated in vitro at OIMP installation, designed and manufactured at “Avangard” Plant in Sarov. The bio-liquids structure was examined with a software-hardware complex on the base of “Morphotest1” [1].

As a generalized quantitative parameter, characterizing alternating electromagnetic fields effect on the bio-liquid, total length of cracks in the bio-liquid facies (film) was chosen. Analysis of cracks distribution over the

drop diameter enables obtaining analytical dependencies “cracks length – field parameters” [2,3].

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MACROCELLULAR CORES OF HYPOTHALAMUS AT THE COMBINED APPLICATION OF ELECTROMAGNETIC AND IONIZING RADIATIONS

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In the experiment on white non pedigree male rats the morphofunctional condition of macrocellular nuclei of hypothalamus (MNH) supraoptical (SO) and paraventricular (PV) through 1.7, 5, 24, 72 h after separate and combined influence of electromagnetic radiation (EMR) of microwave range (2.4 GHz, 10 mW/sm²) and ionizing radiation (IR) in a dose of 0.5 and 10 Gr was studied. On the frontal sections of the hypothalamus totalled types of neurosecretory cells (NSC) according to Polenov's classification (1993) was counted, it was done with simultaneous definition of eu- and heterochromatin in their nuclei. (A.N. Yatskovsky, 1987). At the simultaneous EMR and IR application in a dose of 0.5 Gr the amounts of secretory neurons (SN) in a state of superactivity (1A type) in PVN decreases authentically as contrasted to by separate effects of factors through 5 h, and 24 hours, later – in both MNH. Through 72 h MNH number body in spacehold (type II) was detected.

The euchromatin contents in MNH during the experiment remained heightened.

At the combined EMR effect and γ -exposure in a dose of 10 Gr within the first day of the observation in MNH authentically as contrasted to separate exposure of the both sorts, NSC content of 1A type progressively reduced. It was accomplished by the parallel increase of SN number with moderate activity. By the 72nd h of the experiment the NSC amount in state of deposition and rest accrued. The euchromatin predominance in SN nuclei was gradually replaced by the rise of heterochromatin content.

Thus, the combined EMR and IR application causes the depressing of MNH neurosecretory activity, which is magnified together with the increase of a dose of γ -exposure.

CHANGES IN CHROMATIN STATE OF MOUSE LYMPHOID CELLS UNDER THE INFLUENCE OF EXTREMELY HIGH-FREQUENCY ELECTROMAGNETIC RADIATION

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In the last few years, data have appeared permitting to consider low-intensity extremely high-frequency electromagnetic radiation (EHF EMR) as a factor capable to cause genotoxic effects. The purpose of the present work was to study *in vivo* and *in vitro* effects of low-intensity EHF EMR at the level of chromatin of lymphoid tissue cells. Male mice of outbred NMRI line were exposed to EHF EMR (42.0 GHz, 0.15 mW/cm², 20 min) in the far-field zone of a horn antenna. Mice of control group were sham exposed. In 3 hours after exposure or sham-exposure, animals were killed and total fraction of peripheral blood leukocytes and cell suspensions from spleen and thymus were obtained for further analysis. Under *in vitro* conditions, suspension of peripheral blood leukocytes was exposed to EHF EMR (42.0 GHz, 0.05 mW/cm², 20 min) at a room temperature in the far-field zone of channel radiator. A part of the same suspension was used as the control, which was kept for 20 min under similar conditions as exposed one excepting the exposure. Using a comet assay technique, we have shown that low-intensity EHF EMR causes oppositely directed effects on spatial organization of chromatin

in cells of lymphoid organs. After single whole-body exposure of the animals, an increase by 16% ($p < 0.03$ as compared with control) and a decrease by 16% ($p < 0.001$) in fluorescence intensity of nucleoids stained with ethidium bromide were found in thymocytes and splenocytes, respectively. The fluorescence intensity of chromatin in cells of peripheral blood was not changed after the exposure. The exposure of cells of *Raji* human lymphoid line and peripheral blood leukocytes to the EHF EMR *in vitro* induced a decrease in fluorescence intensity by 23% ($p < 0.005$) and 18% ($p < 0.001$), respectively. We suggested that the effects of low-intensity EHF EMR could be determined by changes in a number of physiological alkali-labile sites in DNA of exposed cells.

STRESSFUL REACTION OF ORGANISM WHICH CAUSED INFLUENCE OF ELECTRICAL FIELD (EF) BY FREQUENCY 60 AND 16 kHz

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Experimentally the influence on animal organism (white rats) EF by frequency 60 kHz (10 kV/m ; 1000 and 100 V/m) and 16 kHz (600; 150 and 50 V/m) with a daily exposition 6 hours within while one month was investigated. As a result of the influence the changes of weight coefficients (WC) of immune organs and internal secretion glands – the systems directly participating in stressful reaction organism were observed.

It was revealed that the main subject of EF with 60 kHz frequency influence was the central immune organ – the thymus. It's WC decrease was significant and registered at all intensities and did not come to norm in the post-action period. The weight parameters of spleen were reduced under EF with intensity 10 kV/m and authentically raised - with 1000 V/m.

Also EF with frequency 16 kHz caused decrease WC of the thymus, but only at the lowest intensity (50 V/m), and increase spleen WC - at 50 and 150 V/m. Besides, the condition of endocrine bodies was investigated. In all series of animals the EF influence made for increasing epiphysis and gyphophysis WC, this indexis normalised during period postaction, WC gyphophysis authentically have decreased only at 600 V/m. The increasing of WC suprarenal was more proof, it have registered in all series experimental animal both during action EF and during period postaction. The revealed spectrum

shifts became the important argument for arising intensity of neuroendocrine and immune systems under influence EF of a low-frequency range.

The changes in this systems were accompanied by a number of natural deviations of functional activity peripheral blood cells. At 60 kHz the such significant decrease of weight thymus was accompanied by slowing of lymphocytes mediator activity (on RILM with metogen) and in parallel – decrease of phagocytosis leukocytes activity parameters. The influence EF 16 kHz were characterised essential activation both at function and phagocytosis, that more clearly take place at 600 V/m.

The received results testify to variety adaptate reactions under the stress condition of so close EF parameters, this reactions depends from a degree of changes in the central immunity organs and endocrine adjustment.

PULSE FLOWS OF POPULATIONS OF CORTICAL NEURONS UNDER MICROWAVE IRRADIATION OF DIFFERENT INTENSITY

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Early we found that under microwave irradiation increase and decrease were possible in frequency of background activity of single cortical neurons. However these shifts were inexpressive in comparison with changes of evoked activity. In following investigations we examined peculiarities of pulse flows of neuronal populations since in them accidental fluctuations were leveled and dominant rearrangements were emphasized.

The purpose of the present study was to compare two characteristics - mean values of interspike intervals and the number of spike bursts – under microwaves of different intensities. Experiments were carried out in unanesthetized nonimmobilized rabbits. Irradiation was realize by microwaves with wavelength of 37.5 cm coring 1 min.

It was established that changes as decrease of mean values of interspike intervals were at irradiation intensity of 0.2–0.3 and 0.4 mW/cm². Shifts of the opposite direction prevailed at rise of intensity till 0.5 mW/cm² and rather high intensity – 40 mW/cm². As far burst activity, shifts as decrease of the number of bursts. But rearrangements of pattern of bursts themselves were different at different intensity of irradiation.

Absence of linearity in respect of intensity of irradiation and of observed effects probably related to the complexity and many-component

character of rearrangements themselves in activity of neuronal populations under microwaves.

The project was supported by Russian Foundation of Fundamental Researches (grant No. 00-04-48139).

REPRODUCTIVE CELL DEATH BY APOPTOTIC MECHANISM AFTER INFLUENCE OF HIGH FREQUENCY ELECTROMAGNETIC RADIATION OF LOW POWER ON ORGANISM

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Significance of apoptosis for development and maintenance of homeostasis in organism is well-known (Novikov V.S., 1996). Manifestation of apoptosis is inspissation of nuclear chromatin, condensation of cytoplasm, nucleus breaks up to fragments and cell turns to set of apoptotic slices of different size.

The analysis of apoptotic cells in blood and a bone marrow of animals who have been exposed to electromagnetic radiation (ELM-radiation) of high frequency (39.5 GHz) has revealed dependence of observed effects on repetition factor of influence (single, double, fourfold), time (1 and 6 hours) and combined effect of ELM-radiation and γ -irradiations.

It is established that the observed effects are more strongly expressed at double influence of ELM-radiation during 1 and 6 hours (with interval of one day). In bone marrow the active cell death is observed earlier (in 1 day after influence) and sharply decreased in the remote period (30 th day). In population of blood cells, on the contrary, the apoptotic effect is shown earlier only at increase of time of influence.

The sequence of these influences was important at combination of ELM-radiation and γ -irradiation. In case, when γ -irradiation preceded ELM-radiation, oppressing effect of the first agent (grows the share of apoptotic cells) enhanced. At change of the sequence of influence (ELM-radiation + γ -irradiation) injuring effect of ionizing radiation on blood cells and bone marrow was reduced substantially.

Thus, change of frequency of apoptotic cells indicating cell death by apoptotic mechanism testifies to the infringement of homeostasis in organism.

The obtained experimental data may be used in study of effects and regulations of high frequency ELM-radiation.

MULTIFREQUENCY MICROWAVE RADIATION EFFECTS ON BEHAVIOR

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This study was designed to use behavior to determine whether radiofrequency radiation (RFR) exposure by multiple frequencies will produce unique biological effects that are different from single frequency exposures of the same specific absorption rate (SAR). Experiments have been conducted in two phases to meet this objective. First, a computer model containing detailed anatomical data for the rhesus monkey (1.25 mm voxel size) has been used with the finite difference time domain (FDTD) procedure to predict the specific absorption rate in the monkey at 200 MHz and 3000 MHz. Empirical dosimetry experiments have been conducted to verify and refine the model. Second, rhesus monkeys (*Macaca mulatta*), trained on a vigilance task, have been used to develop dose/response data to compare the effects of single frequency and multifrequency RFR exposure. Monkeys were exposed to RFR at the frequencies listed above with power density systematically varied at each frequency to establish a threshold for behavioral change. The vigilance task was easily trained and required a monkey to monitor for the occurrence of a brief visual stimulus. A high rate of lever pressing behavior was trained on one lever (variable interval) and reaction time recorded on a lever press of a second lever during a brief display of the stimulus to earn food reward. Behavioral test sessions were 60 min duration five days per week. In conducting these studies, a simple test protocol has been followed to 1) establish a stable behavioral baseline of performance and then 2) determine the effects of RFR at various dose rates on the baseline performance. Generally, the variable that showed most change during exposure was right-lever response rate. Left-lever reaction time, post-reinforcement pause time, and post-choice pause time did not change. In this experiment we have evaluated the effects of combined exposures on rhesus monkey ability to perform a vigilance task and determine the threshold that causes work stoppage.

EVIDENCE ON THE EFFECTS OF ABNORMAL MAGNETIC FIELDS ON STRESS COPING

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We have investigated various biological effects of the following altered electromagnetic fields (EMF) 1) disturbed geomagnetic field (generated by an irregularly varying field: range -0.2 to $+0.7$ G); 2) hypogeomagnetic field (obtained by mu-metal shielding: to 0.001 G); 3) extremely low frequency EMF (37 Hz, 0.8 G); 4) geomagnetic disturbances by solar storms.

Geomagnetic field disturbances alter the initial orientation of homing pigeons released far from their loft (Papi et al. 1983) This seems to be due to an incapacity, provoked by EMF, to compensate for stress induced by manipulation. Pre-treatment with naloxone, which antagonizes the endogenous opioid system (involved in stress-coping), is also known to produce a disturbance in pigeon orientation and EMF disturbances decrease mu-opiate receptors in the brain and increase pain sensitivity (Papi et al. 1992; Del Seppia et al. 1995). Finally, a similar orientation disturbance is observed after other stresses (e.g. immobilization; Del Seppia et al. 1996) and the tranquillizer promazine removes this disturbance either if induced by EMF or by stress (Luschi et al. 1996).

Abnormal EMF (37Hz, disturbed geomagnetic and hypogeomagnetic field) consistently increase pain sensitivity in mice by suppressing stress-induced hypoalgesia (i.e. pain reduction in alarm conditions) (Del Seppia et al. 2000, Choleris et al. 2002).

Abnormal EMF (disturbed geomagnetic field, 37Hz) increase pain sensitivity in humans as well and alter pain-evoked potentials (Papi et al. 1995, Sartucci et al. 1997). In addition 37Hz EMF and solar storms increase arterial blood pressure (Ghione et al. 1997, 1998).

Our results thus indicate that a disturbed geomagnetic environment may alter various behavioural and psychophysiological parameters related to stress responsiveness (escape behaviour, pain perception, blood pressure). These findings are consistent and confirmed in various animal species, and suggest that EMF may affect some important physiological mechanism(s) involved in stress-coping mechanisms, which are highly conserved in vertebrates.

THE EFFECT OF CONSTANT MAGNET FIELD ON THE AMYLASE ACTIVITY

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The effect of constant magnet field (CMF) on the total activity of amylases extracted from the germinated wheat seeds was examined. The tension of CMF was been regulated by changing the distance between the poles of magnet using the insertions of tender steel. The time of incubation of reaction mixture (starch and amylases solution) was 15 minutes by temperature 25° C.

In our work (with the assistance of N.I.Kurganova) it was showed that beginning from 1300 E the level of amylase reaction decreases with the lowering speed in the vessel situated between the magnet poles. By 3800 E the speed of reaction was 8.3% lowed comparing with the control (without magnet). The preliminary action of CMF on the amylase activity did not influence the following reaction rate in the normal conditions. The preliminary influence of CMF on water or starch solution led to the decrease of reaction rate. Taking in mind the technology of the solution preparation we used only the partial (25 and 50%) addition of magnet-prepared water. In the case of preliminary action of CMF on the starch solution the inhibitory effect increased with the time of magnet influence increase and reached its limit almost equal for tension of 1900E (7.7%) and 2600 E (7.9%). The use of magnet-processed water led to the decrease of amylase activity to 2.7% and 3.6% by 25 and 50%-reached solutions.

The inhibitory effect of magnet-produced starch gradually decreased and by 20° C disappeared after 3 hours.

Thus, the CMF in our experiments initially effected the water structure and by this way – the reaction rates.

THE IMMUNE STATUS OF ORGANISM DETERMINES SENSITIVITY OF MAMMALS TO MICROWAVE IRRADIATION

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The purpose of the work was the study of influence of low-density electromagnetic waves (8–18 GHz, 1 $\mu\text{W}/\text{cm}^2$) (MW) on the immune system of mice with the different immune status. In this study some animal models with

immunodepressive or immunoactivated states were used. In addition, these models were differentiated according to a degree of their immunodepression or immunoactivation. To activate the immune system, the mice were immunized by bovine carboangidrase, and the level of the initial immune status varied depending on the ways of immunization (with Freund's adjuvant or without it). It was shown that centimetric MW activated antibody production up to physiologically level, which activated, for example, by immunization procedure. Tumor-bearing mice with different growth rates of neoplasm were used as immunodepressive model. We detected a significant immunostimulating influence of electromagnetic waves on TNF production toward exhausted immune system. Microwaves increased TNF production of immunodepressed tumor-bearing mice up to the value, which is characteristic for immunoactivated mice. Besides, the high efficiency of immunostimulating effect of MW as compared with natural immunomodulators (mixed diet with β -carotene, α -tocopherol and ubiquinone) was detected.

Thus, we observed the similar patterns of MW effect on the immunity of both animal models with immunodepressed and immunoactivated immune status. So, most responsive to effect of MW is the immune system of animals with lowest basic immunity. In summary, it may be proposed that MW holds great promise for cancer therapy and immunocorrection.

STUDY ON SOME STRUCTURE FUNCTIONAL PROPERTIES OF ERYTHROCYTE MEMBRANES UNDER THE EXPOSURE TO MM-RANGE LOW INTENSITY ELECTROMAGNETIC WAVES

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The direct action of low intensity coherent electromagnetic waves of mm-range on the structure-functional properties of erythrocyte membranes was studied in vitro. Both the whole blood taken from the sublingual vein of white inbred rats and the erythrocyte mass, obtained after the centrifugation of blood samples, were exposed to radiation. As the source of radiation the generator "Yav-1" functioning in the regimen of modulation on the frequency was used (wavelength of 5.6 mm; dose power of 10 mW/cm²). The samples were exposed to radiation during 15 minutes. Experimental data was compared to non-irradiated control, that is, to the samples of whole blood and erythrocyte mass maintained under the same conditions as the test samples,

but without the radiation exposure. Passive permeability for K^+ ions, the level of lipid peroxidation of erythrocyte membranes, membrane potential and erythrocyte deformity were determined.

It was revealed that irradiation of both whole blood and the erythrocyte mass during 15 minutes brings to the following significant changes: the decrease of K^+ passive permeability by 40%, decrease of erythrocyte membrane potential by 30%, decrease of erythrocyte deformity by 40%.

The comparison of our findings with data obtained earlier in animals exposed to total irradiation by the above-mentioned waves indicates to the diversely directed changes of structure-functional properties of erythrocyte membranes, thus signifying the presence of both direct and indirect effect of mm-range electromagnetic waves on the erythrocytes.

ABILITIES OF AN ORGANISM TO ADAPT TO THE INFLUENCE OF A CONSTANT ELECTRIC FIELD (CEF)

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The aim of the systematic quantitative research is to investigate the peculiarities and regularities of formation and manifestation of inborn unconditioned reactions (UR) and modified conditioned reflex behaviour linked to the influence of CEF combined with negative aero-ions.

The research was carried out with a Vistar population of 244 rats, weighing 190±10 grams. Behavioural responses were formed in Ж-shaped closed, complex maze according to the methods of L.G. Voronin and K.A. Nikolskaya (1993). The above methods allowed the analysis of the experimental data from the point of view of the information theory according to Shannon. The duration of each experiment was 20 minutes. Conditioned food reflex (CFR) was considered developed, if the animal for two successive experiments reproduced CFR with the 0.8 probability.

The rats were exposed to the influence of the electric field in a camera between two parallel aluminium plates distanced in 70 cm from each other. The upper electrode received negative potential from high voltage static transformer ПBC-160, the lower electrode was grounded. In different series of experiments the field tension was 30, 60, 90, 120 and 160 kV/m², with the density of the ion current 3, 19, 27, 43 and 76 mA/m² accordingly. ПBC-160. Duration of CEF exposition was 4 hours every 24 hours for 30 days. After the exposition CFR was formed in the maze. The exception constituted CEF

90 kV/m², where the dynamics of the behaviour was investigated with six groups every five days (with one group after 5 days of exposition, with another after 10-days exposition etc.). In every series of the experiment there were three groups of rats: experimental, control and season norm with 10–12 animals in each. Conditions and feeding in the vivarium conformed to usual standards.

It was found out that CEF caused unidirectional changes in the characteristics of unconditioned and conditioned reflexes demonstrated by the animals. As the tension of the field increased, at first, quantitatively, and then qualitatively, the whole activity of the organism changed accordingly. The first reliable stimulating effect of the field linked to the process of accumulation of information was discovered at the tension of 30 kV/m², although it did not change the overall effectiveness of learning. Increase in the field tension up to 60 kV/m² stimulated accumulation of information, formation of locomotion solutions, and skills optimisation.

Increase in field tension up to 90 kV/m² considerably altered the accumulation of information. The volume of the working memory increased, however, the animals learned both useful and redundant information, which significantly broadened the range of locomotion solutions. Certain duration of the field exposure at the given tension brought about a stable pathologic state with the rats: memory disorders, conditioned reflexes disorders and behaviour disorders in general. The disorders observed are analogous to the disorders in hypompactomy and comparable with the basic signs of the Corsac complex of symptoms. (Authorship SU 1382256). Still further increase of CEF tension up to 120–160 kV/m² decreased accumulation of useful information in the maze, and the ability to analyse the wrong and redundant motions. The effectiveness of locomotion optimisation slowed down even more with further increase of the field tension. The disorders in adaptation generally increased, the ability to form an adequate succession of the moves in the maze dropped, as well as the ability to differentiate the biological significance of irritants, which is one of the basic characteristics of the higher integrative brain functions.

ELF ELECTRIC FIELD INHIBITS PROTEIN SYNTHESIS

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All living organisms are continuously exposed to both natural and man-made electric fields. We live a large part of our lives surrounded by a grid of wires that delivers the energy we need to power lights, electric motors, and many of the conveniences that make modern living possible. The majority of our exposure comes from fringing fields generated by the power distribution systems. Living organisms interact with this environment of electric and magnetic fields. The question is did they complete the adaptation period to this environment of electric and magnetic fields. We think, they did not yet, at least they didn't accomplish the process of adaptation.

In this investigation the effect of Extremely Low Frequency (ELF) Electric Field which we are exposed to in daily life, on collagen synthesis was studied under different exposure periods. The effect was evaluated by assessing the amount of hydroxyproline in the liver tissue. 1.35 kV/m electric field with 50 Hz frequency was applied to 40 guinea pigs in 4 different application times being 1 day, 3 days, 5 days and 7 days with daily exposure period of 8 hours. 15 guinea pigs were also kept in the same laboratory conditions and served as control without any electrical field application. At the end of each exposure period liver hydroxyproline contents were determined with the Stegemann-Stalder's method.

The applied electric field was found decreased hydroxyproline amount of liver tissues significantly in all of the exposure periods w.r.t the controls suggesting decreased synthesis of collagen under ELF Electric field.

In the investigation current intensity and current density values on the surface and inside of the guinea pigs and human models were also calculated.

ELECTRIC FIELDS HAVE EFFECT ON FREE OXYGEN RADICAL SYNTHESIS IN PLASMA, LIVER, LUNG, KIDNEY, TESTIS, BRAIN TISSUES

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Electric (E) field stimulation generate activated oxygen molecules. Reactive oxygen molecules derived from the reduction of molecular oxygen during physiological and pathological process may cause acute and chronic tissue damage. Oxygen free radicals are normally neutralized by very efficient systems in the body. These include antioxidant enzymes like superoxide dismutase (SOD). In a healthy subject, there is a balance between free radicals and the levels of antioxidants. The increase/decrease in radicals can be traced with the variation in malondialdehyde (MDA) level.

The aim of this study was to examine free oxygen radical synthesis in plasma, liver, lung, kidney, testis and brain tissues by observing MDA and SOD levels in each tissue under the effect of 50 Hz Electric field in different application times.

1.35 kV/m Electric field with 50 Hz frequency was applied to 75 male white guinea pigs (150–200 g) in 5 different application periods being 1 day, 3 days, 5 days, 7 days and 10 days with daily exposure of 8 hours. Duration of E field exposure was from 9 a.m. to 5 p.m. each day. Guinea pigs were examined in five different groups according to the exposure periods. In each group 15 guinea pigs were exposed to the field. 20 Guinea pigs, which were not exposed to any electric field, served as control group. Taking into consideration that placing more than one animal per cage would create a stress factor, only one animal was placed per cage during each E field exposure period.

The effect of E field to MDA and SOD levels is investigated according to the application period. It is observed that E field application in each period increased both SOD and MDA quantities compared to the control. The statistical evaluations indicate that the MDA and SOD quantities increased more when the electric field application period is increased. Ten days, 7 days and 5 days applications are found more effective in those increases.

EFFECTS OF A GEOMAGNETIC FIELD AT RHEOLOGICAL PARAMETERS OF HUMAN BLOOD

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The analysis of dynamics of rheological parameters of human blood depending on disturbances of a geomagnetic field is carried out. We determined the viscosity of integral blood, haematocrite, concentration of fibrinogen, ability of erythrocytes to aggregation, and aggregation of thrombocytes. It is shown, that all parameters, investigated by us, did not overstep the bounds of normal fluctuations per quiet days, while the majority of the characteristics, examined by us, begins to change already before the beginning of geomagnetic storm. In disturbances days the average sizes of parameters of erythrocytes aggregation and aggregative activity of thrombocytes are exceeded their meanings values in the quiet days on 40–60%.

Two kinds of influences of variations geomagnetic field on rheological property of blood are considered:

- Blood as electromagnetic system is sensitive to changes of external electromagnetic fields. The membranes of crates are the main vulnerable part; phospholipides are their structural basis and its have effective thromboplastic action, increasing thrombocytes-vascular haemostasis. Under action of electromagnetic fields they release from membranes of crates, in particular, of the thrombocytes, strengthening of haemostatic potential. It can become the reason of cardio-vascular complications, which are observed during geomagnetic storms.

- The haemorheological shifts can be a result of influences of electromagnetic field through compulsory synchronization of rhythms electromagnetic oscillations of crates of the central nervous system. There is a stressful reaction at development of the resonant phenomena, that conducts to occurrence in blood “hormons of stress” – catecholamines and glucocorticoids, which is influence on activation of coagulative system direct and indirect, increase of aggregation and spasm in vessels of a microcirculating channel.

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STIMULATION OF YEAST BY ACTION OF LASER RADIATION

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It is a common knowledge that most not photosynthetic microorganisms (yeast cells including) which don't have any photoreceptors known to science can be stimulated by means of weak optical radiation in some spectral bands. The results of such radiation were as follows: the increase of activity of a number of ferments, the intensification of growth, the increase of the velocity, of protein synthesis and of general biomass outlet. But until recently all attempts to clear up molecular sources of photo stimulation have failed. It was only in the researches of P.N.Lebedev physical institute RAS that light-oxygen effect was discovered. The effect accounts for the influence of "red" light of He-Ne laser and a number of other spectral ranges of laser radiation-LR.

The primary act of light oxygen effect consists in the following: photon excites low lying levels of dissolved molecular oxygen, the result of it being the formation of singlet oxygen having an extremely high biological activity. When the dose of radiation is small the energy of singlet oxygen influences not photo-chemical transformations but the change of dynamic net of hydrogen bonds in the surrounding aqueous medium volume. Being in the medium cells are influenced by the changed structure of aqueous matrix and can pass into the state of increased activity.

An experimental research on laser stimulation of yeast cells suspension *Saccharomyces cerevisiae* has been conducted by us. As a source of LR we used a semiconductor laser radiant at wave length 1264 nm in the maximum of I absorption band of dissolved oxygen and He-Ne-laser radiant at wave length 632.8 nm in the maximum of IV band O_2 . The activity (the energy of fermentation) of yeast cells has been determined by formation of CO_2 in the process of fermentation in real time during 24 hours on a special installation. The research showed that an optimum dose of radiation for yeast photo stimulation is over the range of 20 to 60 mJ. Relative independence of the quantity of optimum dose from the suspension volume over the range of 10 to 500ml has been defined on condition a radiated sample is stirred.

Experiments with He-Ne laser showed that the preceding action of LR on aqueous solution of vitamin C increases essentially the vitamin's ability to exert stimulating influence on yeast cells.

On the whole the results of the experimental research prove active participation of singlet oxygen in the mechanisms of LR action and the importance of arising changes in aqueous matrix structure in the realization of the ways and mechanisms of this action.

PECULIARITIES OF CHANGES OF EMOTION-MOTIVATIONAL BEHAVIOR OF RATS AFTER ACTION OF ELECTROMAGNETIC FIELDS OF A DIFFERENT IN- DUCTION

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The investigations were carried out on white, not thoroughbred, nonaggressive, male rats. The action by electromagnetic fields (EMFs) meant short-term (30 min) and prolonged (180 min) influence of four different induction (1.5, 2.0, 2.8 and 3.6 mT) and power frequency EMFs.

On the basis of the analysis of the received data has come to light, that behavior of rats in conditions, unfamiliar for them, is not indifferent to action of electromagnetic fields and about it specify the following facts:

After half-hour action of any interesting for us induction EMFs the rat's reaction of fear amplifies and at stay in open conditions the instinct of search of the covered place lingers over, that is reflected in authentic increase of the latent period of an exit from the central circle of an "Open field". At increase of time of influence till three hours, during action of 1.5 and 2.0 mT induction EMFs some rats in groups develop habituation on influence of the given factor. In spite of the fact that the center circle leaving time of the given groups animals is greater, than similar parameter at the appropriate control, this quantity, because of increase of standard mean error, nevertheless does not exceed reliably time of an exit from the center those rats, which have undergone the prolonged influence of imaginary EMF. In our opinion the above-stated fact speaks about a various susceptibility of the different individuals to action of EMFs. In groups of 180 minutes influences to the highest in our case induction (2.8 and 3.6 mT) EMFs in rodents the accustoming to action of the given factor is not marked. The total time of an output of these animals from the central circle of an arena also is confidentially more than similar parameter, revealed by a control animal, as well as in case of 30 minutes influences to the EMFs. In the given work was shown, that from different induction EMFs, though not very distinguished from each other, everyone

renders on rats' organism influence of own kind. And it has come to light in behavior of rodents after overcoming a "barrier of undertaking of movement".

AN ATTEMPT TO REPLICATE MICROWAVE EFFECTS ON CALCIUM EFFLUX FROM CHICK BRAIN

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Reports have appeared purporting to show increases in calcium efflux from avian brain as a result of exposure to electromagnetic energy. Though no hazard for humans has been ascribed to this effect, these reports are often cited as evidence of dangers to human health. Because of these concerns, we have attempted to replicate the original study in our laboratory. Chick brains were excised and loaded with $^{45}\text{Ca}^{2+}$ during a 20-min incubation period. The brains were placed in fresh media and exposed to 147 MHz radiation in a TEM cell. Efflux of $^{45}\text{Ca}^{2+}$ was estimated using liquid scintillation counting. There were no differences in calcium efflux in the exposed brains compared to control brains.

BIOCHEMICAL REACTIONS SUBJECT TO FAST RISE-TIME RAPID-PULSE RADIO FREQUENCY RADIATION

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The search for biochemical reactions that would be uniquely sensitive to fast rise-time rapid-pulse radio frequency radiation (RFR), based on first principles, is limited by the constraints of kinetics and thermodynamics. Most biochemical reaction turnover times are between 1 microsecond and 10 nanoseconds. The fastest biochemical reactions are proton and hydroxyl ion transfers that approach turnover times of 10 picoseconds. Electron transfer is the fastest of the biochemical reactions when only the intramolecular transfer is considered. Then, the transfer time approaches the time constant for molecular vibrations—that is, 100 femtoseconds. These reactions are also more likely to be affected by electric and magnetic fields because they

involve electrons rather than bulky cations, unlike ion transport in membranes (which operates at a transfer rate of about 10^8 per second). The intensity of the field effects must be sufficient to overcome the free energy required to free ions from bound water or binding sites on proteins or membranes (thus the thermodynamic threshold requirements), which further limits the interaction with fast pulsing fields. Therefore, based on first principles, the rapidity and intensity of RFR pulses become the limiters of the types of biochemical reactions that can be affected by such pulses. We shall present data that shows an artificially contrived biochemical reaction, the oxidation and luminescence of the organic semi-conductor diazoluminomelanin (DALM), that meets these criteria. The reaction shows accumulation of pulse effects over finite time periods and the relaxation of such accumulation to a baseline starting rate. These effects can be modeled based on simple steady-state kinetic and thermodynamic calculations, although the physical chemical mechanism still remains to be defined. Although this biochemical reaction has been considered wholly artificial until recently, it now appears that there is accumulating circumstantial evidence that biochemicals similar to DALM, that is, poly-nitro-tyrosine or -diaz-tyrosines actually are made and reside in living cells and tissues. Efforts are being made to test this hypothesis. This work was sponsored in part by the United States Air Force Office of Scientific Research and represents the sole opinion of the author and not that of the United States Air Force or any other United States of America Federal Agency.

THE THERMONEUTRAL ZONES AND THERMOCOMPENSATORY REACTIONS OF ANIMALS AT MICROWAVE EXPOSURE

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For the purposes of hygienic standardization of microwaves for professional workers one should take into account the modifying influence of high ambient temperature on the thermogenic effect of microwave radiation.

Thermogenic effectiveness of electromagnetic irradiation (EMI) of UHF range (7 GHz) dependent on the intensity ($10\text{--}50\text{ mW/cm}^2$) and environmental temperature (22° and 30°) was studied in experiments with mice, rats and rabbits. During microwave exposure, the rectal temperature of animals was continuously monitored.

It was shown that the air temperature of 30° C, which belongs to the thermoneutral zones of mice and rats, increased the speed of microwave heating of animals significantly. The microwave exposure of mice with SAR of 12 or 14 W/kg (20 or 35 mW/cm²) for 1 hour at the ambient temperature of 22° C did not result in increase of the body temperature, whereas microwave exposure at 30° C resulted in a significant rise of the rectal temperature ($\Delta T = 0.9$ or 1.1° C, respectively). During microwave exposure of rats with SAR of 5.3 or 8.2 W/kg (25 or 40 mW/cm²) at 22° C, the rectal temperature showed gradual rise, and then remained at the achieved plateau level for at least 3 hours. During microwave exposure of rats at 30° C, the faster gain of the body temperature resulting in microwave overheating and death was observed.

The thermoneutral zone for rabbits lays slightly below 30° C, which practically coincides with thermoneutral zone for a suit-dressed man (15–25° C). Microwave exposure of rabbits with SAR of 0.7 or 1.5 W/kg (10 or 20 mW/cm²) for three hours at 22° C actually did not result in an increase of the body temperature above physiological fluctuations. During microwave exposure at 30° C, the overheating of animals developed, resulting in their death.

Thus, high ambient temperature, even in the thermoneutral range, enhances the thermogenic efficiency of the microwave radiation significantly. It is concluded that this interaction should be taken into account for hygienic standardization of non-ionizing EMI.

THE WEAK MAGNETIC FIELD INFLUENCES ON THE STATE OF CIRCULATORY SYSTEM IN RATS

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It is well known that information overload is one of the factors provoking diseases in blood, cardiovascular and nervous systems of humans. Cognitive activity of modern humans is realized in conditions of increased level of magnetic field (MF) background produced by electronics. The aim was to study the state of fibrinolytic and haemostatic parameters of blood in Wistar rats being learnt on a background of a weak static MF for a long period.

Information overload was a food-getting problem situation in a multialternative maze where rats had to form by themselves complex operant habit. Three experiments were carried out: 1) free behavior was observed in conditions of "living room" (control, Exp.1), where magnitude of MF induction varied from 12 μ T to 210 μ T. The learning was observed on the background of natural MF, $B=37 \pm 2 \mu$ T (NMF, the Exp. 2) and on a background of static MF up to 300 μ T (SMF, the Exp. 3). The state of 12 parameters of fibrinolysis and haemostasis were studied before and after learning.

It was found out that the rats being learnt on SMF (the Exp. 3), unlike 40% of control ones (the Exp. 2), could not form food operant behavior by themselves. They formed adequate behavior only after a brief external stimulation, though habit was very unstable and was accompanied by active stress reactions. The psycho-emotional strain produced by the learning process in Exp. 2 has activated both fibrinolytic and haemostasis systems, however, these changes were balanced and had adaptive character. Unlike the Exp. 2, the learning on background of SMF was accompanied by the development of hypercoagulation state. These effects were preserved during long time (30 days).

The data obtained testifies that weak MF fluctuations (not more 300 μ T) modulated by magnets increased a sensitivity of fibrinolytic system on different influences including information overload. It had negative effects since profound hypercoagulation was developed if the living system was involved in cognitive process and has been preserved during 30 days after abolishment of the overload. It is under discussion that the cause of disturbances in functioning of fibrinolytic system might be conditioned by a stable stress state, provoked by unfavorable external magnetic conditions for realizing cognitive activity, although these MF fluctuations were small.

THE INHIBITION IN VITRO OF THE COMPLEMENTARY ACTIVITY OF SERUM BLOOD BY LOW INTENSITY PULSED RADIOFREQUENCY ELECTROMAGNETIC FIELDS

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The research of *in vitro* coupling effects of pulse electromagnetic fields (EMF) with macromolecular and supramolecular systems allows to evaluate primary gears of the influence of the fields, than the experiments *in vivo*. The complementary activity of donor serum of a human blood was studied after it had been irradiated *in vitro* by the continuous and pulsed radiofrequency EMF

within 30 min exposure, at 20° C and at identical in all modes values of average power densities 60 and 240 $\mu\text{W}/\text{cm}^2$. The EMF pulse-repetition rates was 16, 32 and 64 Hz at 1-ms pulse width. The activity of a complement was determined on hemolytic reaction in the donor serum of a human blood, which one was directly held after the end of the irradiation. The analysis of the obtained results has shown, that the EMF irradiation authentically reduces complementary activity of the serum of blood as compared with the control at a pulse-repetition rate of 16 Hz ($p < 0.05$), at 32 Hz the tendency was marked only ($0.05 < p < 0.1$), whereas at 64 Hz and in a continuous radiation made the found changes were uncertain. At the same time the correlation between a degree of a decrease of complementary activity of serum of blood and peak (amplitude) values of EMF impulses was marked with the identical in all values of average power densities. It is possible to suppose, that the EMF irradiation with pulse repetition frequency of 16 Hz influences on the stage of forming the membrane attack pathway ($C_{5B}-C_9$), thereby making difficult the formation of functional pores in membranes of cages – targets (erythrocytes), that results in a decrease their further lysis.

RADIOPROTECTION ASPECT OF LOW FREQUENCY PULSED MAGNETIC FIELD EXEMPLIFIED BY LETHAL IRRADIATION OF RATS

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The present paper refers to the experimental research of radioprotection aspect of low frequency (up to 100 Hz) magnetic field (MF) of low intensity (up to 5.2 mTl) that is pursued in RFNC-VNIIEF within the framework of the technology development aiming at human organism protection from ionizing radiation (IR).

In the experiments there were used 75 white non-breed male rats weighting 190–230 g and subdivided into three groups ((1) the reference group; and two experimental groups). All the animals were exposed to bremsstrahlung ionizing radiation with the average quantum energy of 1.1 MeV in the amount of a lethal dose (9.5 ± 0.5 Gr per an average length of the body). The MF efficiency was estimated as related to a standard chemical radiation protector B-2. The reference group was subjected only to the ionizing radiation. The other two groups were subjected to IR; chemical

radio-protector, and MF with varying maximum value of magnetic inductivity in the working area center (from 2.3 up to 5.2 Tl). Upon th IR exposure, the animals developed a sharp radiation-induced syndrome of a mixed (haematogenic/intestine type).

The MF radioprotection quality was estimated based on animals' average life expectancy (ALE) variation and mass decrease dynamics. Statistical analysis was performed using the standard t-criterion of Stewdent and the criterion of Kolmogorov/Smirnov.

As a result, it was shown a credible ALE prolongation for those animal groups, which underwent preliminary MF exposure and chemical protector injection, as compared to the reference group ($p \leq 0.001$). Besides, the experimental groups differ form the reference group in terms of weight decrease dynamics ($p \leq 0.001$). No other distinctions between the experimental and reference animal groups was found out.

The aforementioned results validated the radioprotection effect of magnetic fields, if the latter are use din modes specifically developed in RFNC-VNIIEF, while the MF efficiency is comparable to that of conventional chemical protector.

24 HOURS MONITORING OF EMF EXPOSURE AND HEART RATE VARIABILITY IN SUBJECTS WITH “ELECTROMAGNETIC HYPERSENSITIVITY”.

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Results of physiological examinations indicate that patients with electrohypersensitivity (EHS) have imbalance of autonomous nervous system and increased responsitivity to sensor stimulation, therefore we investigated relationships between HRV and “real-life” EMF exposure in this group. 14 patients (46.5 ± 9.6 y.o) and gender-age matched control group took part in the study. Holter 24 hours recording of HRV and individual monitoring of EMF by EMDEX-II log device have been used.

Results. Hourly recorded HRV data show significant difference between groups in low- and high- frequencies bands (0.04-0.15 Hz and 0.15-0.4 Hz respectively). Persons with perceived electrical hypersensitivity have indications of dysautonomia with increased nocturnal sympathetic tone and de-

creased parasympathetic activity. These deviations in circadian rhythms could explain general neuroasthenic symptoms that occur in this syndrome.

No difference between groups were found in EMF exposure as measured by hourly averaged EMDEX variables. Preliminary data indicate however correlations in both groups between levels of magnetic fields and low and high frequency HRV bands, that should be however further investigated to exclude causality due to physical activity.

THE STUDY OF EMF EFFECTS ON BIOELECTRIC BRAIN ACTIVITY ON CATS

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In our days the great amount of experimental data obtained about the microwave effects on the human and animal brain but the mechanisms of such phenomena is not completely discovered yet. One of the possible explanations was proposed that microwave reception is mediated by auditory sensory system.

The EEG registration was performed from vertex by carbonic electrode under weak pulse modulated microwave stimulation (current frequency 980 MHz, 50–100 mcW/cm²). The re-distribution of spectral density was yielded between the normal maximum band and the 12–18 Hz diapason. The same changes were recorded by the analogous modulated acoustic signals.

The specifically spectral dynamics was discovered in the subsequent experiments with the EEG registration from the auditory, parietal and sensory-motor cortical areas. After the first minute of EMF exposition was discovered reorganization of brain activity from recorded sites of brain the same as it was at the vertex. The most pronounced changes took place in auditory cortex. Such re-distribution of spectral compound power hasn't received when auditory receptor cells of organ of Corty were damaged by oto-toxins.

The study of EMF effects on auditory EPs showed that most pronounced influence on the amplitude of EPs is possible to record when the EMF impulse precedes the acoustical stimulation by 5–10 ms. EMF impulses also influence the amplitude of auditory nerves potential evoked by short clicks. In this case, the EP amplitude changes depend on the delay between stimuli. The data obtained points on the possibility of the auditory sensory system mediated mechanisms of microwave effects on central nervous system.

EFFECTS OF COMBINED CONSTANT AND VARIABLE LOW-FREQUENCY MAGNETIC FIELDS ON BIOLOGICAL OBJECTS

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The paper presents the results of the investigations of combined action of constant magnetic field (CMF) and low-frequency variable magnetic field (VMF) on biological objects: human leukocytes and erythrocytes, frog nerve fibres.

The magnetic systems were used. Some experiments were carried out in specially designed tomographic-type magnetic system. Along with sinusoidal VMFs rectangular and triangular VMFs were used having different Fourier-series expansions. During the experiments the biological objects were held under optimal temperature.

The susceptibility of the processes of lymphocyte migration in capillary to the combined action of CMF and VMF was found.

Changes in hemoglobin porphyrinic macrocycle in human erythrocytes were revealed with the help of resonant Raman scattering technique.

The effects of combined action of CMFs and VMFs (sinusoidal, rectangular and triangular) on frog nerve excitability (the thresholds, amplitude and the rate of action potential propagation) were found at several field parameters. It is necessary to note, that the effects were more expressed in the presence of NO⁺ paramagnetic ion.

INFLUENCE OF HIGH FREQUENCY ELECTROMAGNETIC RADIATION ON SOMATIC CELL GENOME IN DIFFERENT TISSUE SYSTEMS OF ORGANISM

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The paper gives the characteristics of molecular-genetic processes in cell populations of bone marrow, blood, thymus and spleen of animals (white rats) exposed to low intensive 39.5 GHz electromagnetic radiation of millimeter range, power density 0.0029 mW/cm², during one hour. The main indices of cell cycle (distribution of cells by stages), number of micronuclei (chromo-

some aberrations) cells, bone marrow, blood, thymus and spleen genetic apoptosis in dynamics (1, 30, 90, 180 days after irradiation) were studied by method of flow cytofluorimetry.

It was established that the observed effects (disturbances of cell division processes, DNA replication and reparation, change of frequency of micronuclei and apoptotic cells) depend on differentiation level and cell mitotic activity.

The frequency micronuclei cells in bone marrow of animals increases to the 30th day and decreases after 90–180 days after exposure. Proliferative activity and reproductive death are the same as the control level.

On the contrary, in blood population of these animals decrease of cell proliferation activity, accumulation of micronuclei cell and increase of reproductive cell death by apoptosis mechanism are observed.

Changes of thymus and spleen cells reactions are noted.

Thus, the observed effects tell that 39.5 GHz millimeter waves exert mediated effect on bone marrow cells genome, blood, thymus and spleen that can cause infringement of their normal function in organism.

IMMUNOMODULATING EFFECTS OF ELECTROMAGNETIC WAVES

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When consider the regularities of microwave effects on the immune system of animals and humans, the new experimental data give an opportunity to state some basic positions. At first, there is a frequency dependence of immunomodulating effects. So, waves with frequencies 40 GHz, 42.2 GHz and 8.15–18 GHz with about $0.3\text{--}1.0\ \mu\text{W}/\text{cm}^2$ power density upon application *in vivo* cause the different changes in immune cell activity: cytokine synthesis, antibody production, lymphocyte proliferation, and activity of natural killer cells. In a general, these *in vivo* effects might be summarized as follows: 8.15–18 GHz microwaves substantially induce stimulating effects on cells of the mammalian immune system; on the contrary, total-body exposure to millimeter electromagnetic waves cause the depressing of some cell activities.

Secondly, we have detected that the efficiency of weak electromagnetic radiation is increased in those of situations, when the initial immune status of treated animals has been depleted. For example, the activation of the tumor necrosis factor and connected with it rising of an antitumoral resistance of

tumor-bearing mice were rather higher when animals with more injurious form of pathology were exposed to microwaves. Our findings showed that stimulation of antibody production in irradiated mice was higher in animals, which initially demonstrated lower immune response, is other acknowledgement of this conclusion.

So, the weak electromagnetic waves under certain conditions induce the stimulation of immunity, but at some changing of a dose or under frequency drift such low-level irradiations result in an immunodepression. It allows to classify these effects as the weak damaging factors, which might be consider as the stressor actions. Thus, the weak electromagnetic radiations at long-term and, especially, at a residential treatment are capable to violate of the immune system function. On the other hand, at some of pathologies that are accompanied with immunodepression, low intense microwaves can successfully be used as a distant way for immunocorrection.

INFLUENCE OF WEAK AND SUPERWEAK ELECTROMAGNETIC FIELDS ON MORPHOGENESIS IN PLANARIAN *DUGESIA TIGRINA*

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The morphogenetic processes in invertebrates are very sensitive to electromagnetic fields (EMFs) as it was shown earlier. To analyze the effect of weak and superweak EMFs, the following models of morphogenesis in asexual planarians *Dugesia tigrina* were used: regeneration after cutting in the two body halves, regeneration after division of the tail end of the body, and asexual reproduction (fission). The effect of combined EMFs (static field – 42 mT and variable field – 40 nT) was studied. The dependence of the effect of EMFs on the frequency of variable field (1–60 Hz) and amplitude (0,01–640 nT) was examined. The combined field increased the activity of planarian fission. This effect was more pronounced at the frequencies of 1, 3.7 and 32 Hz. The experimental groups surpassed the control groups 6–8 times. The amplitudes of EMFs of 40, 100 and 160 nT were more effective for the fission process. The technical noise (50 Hz, 30 nT) did not affect the results. The combined field (3.7 Hz, 40 nT) activated the regeneration processes after cutting the planarians during five days.

EFFECT OF WHOLE-BODY 42.2 GHZ MICROWAVE IRRADIATION ON SPLENIC B LYMPHOCYTES AND NATURAL KILLER CELLS FROM TUMOR-BEARING MICE

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In the ongoing work we studied the effect of microwave irradiation (42.2 GHz, AM 10 Hz, $1 \mu\text{W}/\text{cm}^2$) on proliferative and cytotoxic activities of splenic lymphocytes from normal and tumor-bearing mice. At initial stage of tumor growth it was observed the significant increase of functional activity in both natural killer cells and splenic B lymphocytes. Upon tumor growth, the NK-cell activity decreased, but this activity remained larger as compared to control. Simultaneously, the proliferation of B cells was significantly increased. In opposite, at the later stage of carcinogenesis NK-cell activity increased up to initial level, but the proliferation of B cells was depressed. Therefore, we found inverse relationship between functional activities of B cells and NK. The application of microwave irradiation caused a suppression of B cell proliferation and NK cells activity from both of normal and tumor-bearing mice at 10th day after injection of tumor cells. At later stage of carcinogenesis the effect of microwave irradiation was increased. This period of tumor growth was characterized by significant suppression of NK cells activity and by increasing of B lymphocyte proliferation in tumor-bearing mice.

We hypothesize that the effect of microwave irradiation is mediated by changes of concentration of cytokines, such as IFN- α , IFN- β and IFN- γ , which are well known as the stimulators of NK and suppressors of B cell proliferation. Thus, our results show an opportunity for applying microwave irradiation as immunomodulating resource for improving the immunity of tumor-bearing animals.

EFFECT OF HIGH-POWER MICROWAVE PULSES ON SYNAPTIC TRANSMISSION AND PLASTICITY IN BRAIN NEURONS

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Extremely high power pulses (EHPP) emitted by modern high-peak-power microwave transmitters represent a new and potentially hazardous environmental factor. We explored EHPP effects on neuronal function in isolated rat hippocampal slice model. Slices were exposed in a custom-made chamber at following parameters: carrier frequency, 9.3 or 9.6 GHz; pulse width, 0.5 to 2 μ s; pulse repetition rate, 0.5 to 10 Hz; peak specific absorption rate (SAR), 330 to 780 kW/g; time-average SAR, 0.25 to 3.6 W/g; exposure duration, 2 to 30 min. Microwave heating, as measured with a miniature fiber optic probe or a microthermocouple, varied from 0.3 to 6 oC. In some experiments, effects of EHPP exposure were compared to those of a continuous-wave (CW) radiation at equal time-average SAR. Each brain slice was exposed or sham-exposed only once. Experiments with different regimens of microwave exposure and sham-exposed controls were alternated randomly. Excitatory postsynaptic potentials and population spikes (PS) in the CA1 neuronal field were recorded extracellularly with a glass micropipette following Shaffer collateral stimulation. Plasticity phenomena studied were paired-pulse facilitation (as induced by paired stimuli with a 20-ms interval) and long-term potentiation (as induced by a 2-sec, 50-Hz tetanus). In different experiments, the tetanus was applied before, during, or after irradiation.

The data were collected in more than 190 experiments, which comprised 4 independent series. The only effect observed was a transient and fully reversible decrease in the PS amplitude during irradiation. Apparently, this effect was an ordinary thermal response: it was proportional to the temperature rise but not to any specific parameter of EHPP, and it could also be induced by CW irradiation or conventional heating. The experiments did not reveal any EHPP-specific or nonthermal effects on synaptic transmission and plasticity.

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**DECREASED MUTATION LEVELS IN *SALMONELLA*
TYPHYMURIUM DUE TO EXPOSURE TO 2.45 GHZ
MODULATED MICROWAVES**

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We investigated the effect of a combination of known carcinogens with low electromagnetic fields on the mutation level in *Salmonella typhymurium*. Both continuous and modulated (217 MHz) fields were applied. The Ames IITM assay was used, this is a short-term genetic toxicity assay based on the use of specially selected strains of *Salmonella typhymurium* bacteria containing different types of point mutations in the histidine operon.

The bacteria were exposed to the electromagnetic field during their growing phase (16 h) and/or during the incubation time (90 min) with the mutagen agent mixture (4-nitroquinoline-N-oxide, 125 ng/ml and 2-nitrofluorene, 125 ng/ml). The power density was 8 mW/cm² corresponding to an average SAR of 3.3 W/kg (FDTD) during this latter phase. For each experiment, a non exposed (sham) and an exposed Ames assay were carried out simultaneously in two identical Plexiglas incubators, at 37° C. The waveguide antenna (rectangular horn) was placed at a distance that permitted far field exposure, alternatively above one incubator and the other to avoid cage effects. Each assay corresponded to the repetition of the same culture conditions in 22 wells and was reproducibly repeated 10 times. Growth of the bacteria was controlled both under and after microwave exposure.

A significant decrease in the number of mutations was observed when the bacteria were exposed to the electromagnetic field both during the growth phase and the mutagen treatment phase. It remained unchanged when the bacteria were exposed to CW microwave. Bacteria growth was not modified by the CW or by the PW microwave.

In conclusion, the present work shows an effect due to 217 MHz pulsed 2.45 GHz electromagnetic fields on *Salmonella typhymurium* mutation levels. In these experimental conditions and contrary to expectations, the data suggests a low "protective" effect of electromagnetic field exposure related to the modulation.

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RESEARCH OF LOW-INTENSITY ELECTROMAGNETIC FIELDS ON SOME PARAMETERS OF RAT'S TISSUES

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Taking into account the social significance, insufficient understanding and indefinite-ness of impact of prolonged exposure to low-intensity electromagnetic fields (EMF) of an industrial frequency 50 Hz, an experimental model of low-frequency and intensity lasting EMF action on animals in natural conditions has been worked out. Most of the results were obtained during combined exposure to EMF and traffic noise. Using biochemical and immunological methods, we determined the blood level of nerve growth factor (NGF), the lactate dehydrogenase (LDH) and succinate dehydrogenase (SDH) enzyme activity in the spleen, the nuclease activity in the brain, the number of peritoneal mast cells and the content of histamine in them in one experimental model. The results obtained showed that the animals exposed to prolonged (2 weeks, 4 h daily) with different physical parameters – EMF I (E 360–480 V/m, H 120–150 nTl) and EMF II (E 10–15 V/m, H 800–1500 nTl) – and noise underwent distinct stress influences on the various functional systems depending on the levels of the electrical and magnetic fields. Thus, a 50 Hz EMF I inhibited the LDH and SDH activity in splenocytes irrespective of the noise protection of rats. However, EMF II (with a higher magnetic induction) stimulated the LDH and SDH activity in splenocytes. The activity of acid and alkaline RNAase and DNAase in the brain remained largely unchanged after a 10-fold exposure to EMF I. The content of NGF in blood serum in all experimental series was not significantly different. As an important component of the immune system, the representation of peritoneal mast cells and their stores of histamine, a bioregulator involved in the preparation of the immune system for a response to antigen, was considered. Under chronic EMF I the number of mastocytes tended to increase, while after EMF II it grew significantly, with insignificant changes in histamine in them, which indicates the appearance of immature forms of mast cells.

The data obtained extend our knowledge of the response of the major functional body systems and the degree of stress conditioning of animals resulting from the chronic exposure to low-intensity EMF of an industrial frequency 50 Hz which are widely spread in the human habitat and able to negatively affect the human health.

THE INFLUENCE OF DIFFERENT EXPOSITIONS PERTURBED GEOMAGNETIC FIELD ON THE REGULATION SYSTEMS OF ORGANISM

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The environmental electromagnetic fields pollution is a very important problem today. Some factories and plants have a metal screen. The characteristics of the electromagnetic field in these spaces are very difficult. It is a perturbed geomagnetic field (PGMF). The influence of this kind of fields on THE regulation systems of organism not studied enough.

The effect of THE perturbed electromagnetic field on the organisms was investigated THE influence expositions (14, 30 end 60 days) animals in different PGMF on the process development of high temperature stress. The examination were performed in 54 female rats (m 150–200 g). The concentration of 11-oxycorticosteroid (11-OCS) in the adrenal, liver and blood were measured.

During our exploration in was founded, that 5-multiple influence of high environmental temperature (70° C, 5 min) imposed considerable activation of hypothalamo-hypophysio-adrenocortical system which is realised in the increasing of concentration 11-OCS in THE adrenal tissues and blood and also in the increasing of relative mass of glands. Animals subjected by influence of PGMF revealed the inhibition of hypothalamo-hypophysio-adrenocortical system reaction on the warm press, and in character depended from exposition in PGMF. During 14-multiple exposition in PGMF the changing of relative mass in the adrenal tissue and concentration were absent. In the experiment dealing with 30-days influencing of PGMF the increasing of 11-OCS concentration in blood with warm stresses was less considerable than in animals subjected by screening influence. Exposition of animals during two monthes in PGMF conditions led to less expression of hormones concentration in the adrenal tissue after warm press relatively isolated warm.

So, the prolonged stay of animals in PGMF lead to the decreasing of reserve possibilities of hypothalamo-hypophysio-adrenocortical system, which is revealed in the warm press conditions.

THE INFLUENCE OF THE PERTURBED GEOMAGNETIC FIELD UPON RATS' CONNECTIVE TISSUE METABOLISM

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It's an incontestable fact that electromagnetic field's action which take place both in experiments and in nature have an effect on different aspects of mammals metabolism. The question about regulative influence of the magnetic fields different intensity on regulation of organs and tissues provoke particular interest. The action of perturbed geomagnetic field (PGMF) is least investigated in this respect.

The influence of PGMF upon adult rats after intramuscular implantation of the hydroxyapatite widely used for bone grafting has been studied. Rats were divided into two groups. First group included operated and intact animals, which were put into the permalloy camera. Hydroxyapatite implantation was carried out under ether narcosis in aseptic conditions. Magnetic field's induction in different parts of the camera modified from 0 to 100 μT . Induction gradient was 0–5 $\mu\text{T}/\text{cm}$. Second group included operated and control animals, which were not undergone by PGMF. All rats were killed at two months.

We found maximum increase of the free and peptide-bound hydroxyprolin concentration in rats being in PGMF conditions. Free calcium and nonorganic phosphate levels in serum remained within normal limits in all groups. Significant depressive effect on alkaline phosphatase activity in rat being in PGMF conditions was revealed. We suppose that PGMF normalize the disturbance of glucocorticoid balance in adrenal glands and plasma of the rats with implanted hydroxyapatite.

Thus we conclude that PGMF have modificatory effect on some indexes of the connective tissue metabolism after hydroxyapatite implantation.

THE FUNCTIONAL ACTIVITY OF SECRETORY NEURONS OF HYPOTHALAMUS MAGNOCELLULAR NUCLEI UNDER THE INFLUENCE OF HIGH-LEVEL ELECTROMAGNETIC RADIATION OF DIFFERENT EXPOSURE

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The published results of the researches of the electromagnetic radiation (EMR) influence on the nervous system, including the one on magnocellular nuclei of hypothalamus (MNH), testify to dependence of originating changes on EMR parameters, one of which is – the exposure (H.A. Minkina, etc., 1985).

In the experiment on white non pedigree male rats, with the initial age of 4 months, the morfofunctional state of supraoptical and paraventricular nuclei of hypothalamus after 5-, 7-months' EMR effects with the density of the induced currents 2.7 kA/m^2 at 500, 100 and 50 impulses per one week, irrespectively of their divisibility and duration 15–40 ns was studied. The neurosecretory cellular (NSC) were discovered by paraldehyde colouring-on Gomory, they were calculated with the usage of A.L. Polenov's classification (1993), in the combination of the eu- and heterochromatin content determination (A.N. Yackovskiy 1987) in each functional NSC type.

It was established that the lowering of the functionally active NSC types was watched at 5- and 7-monthly EMR influence in both MNH. At the same time the depressing of synthetic activity to the first period of the experiment, judging by eu- and heterochromatin relation, by the 7th month was replaced by its sharp rise.

Thus, the EMR effects depend on a duration, and in the concerning NSC number they have a one-direction character, but concerning to the synthetic activity they have a phase, not conterminous with dynamics of changes of NSC number character.

BIOLOGICAL EFFECTS OF EMF EXPOSURE ON ETS GENES

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Additional knowledge on biological mechanisms is required to support studies on health risks in populations exposed to electromagnetic fields (EMF). The classical epidemiology approach represents the gold standard, but it is strongly limited by several factors, including the scarce comprehension of the underlying cellular and molecular mechanisms. To provide support for epidemiological observations and with the final aim of identifying new endpoints and early markers for improving molecular epidemiology studies, we present an experimental model based on ETS genes response to EMF exposure.

We had previously shown that EMF exposure (50 MHz radiation, 80% modulated at 16 Hz, with the ELF component corresponding to one of the resonance frequencies for the calcium ions) induces ETS genes both *in vitro* in different cell lines and *in vivo* in exposed mice (Romano-Spica 2000; Mucci 2001). We observed an induction in ETS1 both at transcription and translation level and a parallel decrease in ETS2 protein level, suggesting a possible interference of EMF on pathways involved in the regulation of the ETS gene family. Here, we critically review our results, integrating them with further experiments and new data on other genes belonging to the ETS gene family. Several observations seem to restrict transcription modulations to hemopoietic tissues.

Briefly, the ETS genes are transcription factors characterised by an 8-aminoacid domain able to bind and transactivate a downstream sequence. They are expressed in different tissues; play a role during development, cell differentiation, apoptosis and show reciprocal patterns of expression following cellular stimulation to external agents. Biochemical pathways interfering with the intracellular calcium ion concentration are known to influence members of the ETS family.

Following extended analysis of experimental observations and previous reports, we proposed a hypothetical model of interaction between EMF and ETS, based on possible interference on pathways involving calcium as second messenger, phosphoinositide, protein kinase C and transcription modulations. The whole of these results represents a promising approach to identify candidate markers of exposure and develop epidemiology pilot studies based on new, earlier endpoints of effect.

EFFECT OF A PULSE MAGNETIC FIELDS ON THE OVARIAN FUNCTION OF ANIMALS

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Studies were performed on female guinea-pigs in the series of experiments with a daily 10-min exposure to pulse magnetic fields (PMF generator was used that allowed to obtain magnetic induction of 1.5 Tl, pulse frequency of 30 per minute and duration of 5×10^{-3} s) for 5 and 10 days. Two types of the influence have been approved: I – all four solenoids switched on simultaneously, and II – two paired switching on with a shift of 100 ms.

Microscopic investigation of the ovaries from PMF (I series 5 and 10 days, II – 5 days) guinea pigs revealed plethoric vessels capillary network in the cortical layer, increased number of follicles at different stages of maturation, and fresh yellow bodies at the stage of vascularization or blossoming. In parenchymal cells, the response of organelles characteristic of functional activation in conditions of physiological adaptation was electron microscopically found. Thecocyctic cytoplasm contained numerous mitochondria, from large somewhat hypertrophied with vesicular crists to small oval, and multiple aggregations of liposomes. All this indicates a moderate, within physiological requirements, intensification of hormone-synthesizing metabolic processes in thecal cells.

Histological investigation of the gonads (II – 10 days) showed a tendency towards cystic atresion of cavitary follicles with the mainly unchanged microscopic structure of the cortical layer. The dominant population of folliculocytes and thecocytes was in the state of functional tension. The described responses remain within the frameworks of physiological parameters of adaptation showing an increase in functional activity.

Thus, PMF activates hormonopoiesis in steroid-producing cells within the limits of the functional capacity of the organ.

MORPHOLOGY OF SENSORIMOTOR CORTEX OF CEREBRUM AT CHRONIC ELECTROMAGNETIC EXPOSURE

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The problem of biological effect of electromagnetic radiation (EMR), and also the problems of prediction of effects of chronic exposure of a man, despite of the progress, reached for the last decade, in the field of the majority of directions of bioradiology, remain still actual. In this situation the experimental researches with biological and technical simulation of parameters EMR with the subsequent extrapolation on a man gain the special significance.

Using the morphological and statistical techniques the structure functional state of neurons (N) and gliocytes of fifth stratum of sensorimotor cortex of rats cerebral hemisphere was investigated at exposure of the electromagnetic field (EMF) with the density of the directed currents 0.7 kA/m^2 and frequency 50 and 500 impulses per week (I/w), in independence from their divisibility, during 5, 7 and 10 months.

It was observed that the 5-month's EMF effect considerably enlarged the number of neurons in the state of hyperactivity (GAN), euchromatin-containing gliocytes, that accompanied GAN, and also neurons with appearances of a pyknosis (PMN), on the background of the authentic regress of neurons in „calm” condition – normochromatic neurons (NN) at frequency 500 I/w, that testified the adaptive compensatory response. After 7 months after the beginning of the experiment lowering of NN number were accompanied at 500 I/w by the increase of contents of N of low-level activity (LAN) and their neuroglial index. 10-month's exposure with the frequency 50 I/w affected only the glial environment of the reactive N and resulted in increasing of number of glial cells, with a preferred content of euchromatin, whereas at frequency 500 I/w the significant increase of LAN and PMN, on the background of a low NN contents was scored in comparison with the previous periods of observation, that testified the exhausting of the adaptive possibilities of neurons and discoordination of their reacting.

BIOLOGICAL EFFECTS OF RADIO FREQUENCY PULSES

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Scientists have considered the possibility that a pulsed radio frequency radiation (RFR) can produce effects other than those by continuous-wave (CW) radiation at the same average power. Analysis of biological effects/health implications of pulsed RFR is a complicated endeavor by itself. The task is further compounded by the development of carrierless pulses that encompass a broad, risetime- and pulse duration-dependent frequency spectrum and do not produce apparent bulk heating due to a very low duty cycle.

A single RF pulse lasting from microseconds to seconds with adequate pulse energy is known to cause acute biological effects, such as brain enzyme denaturalization, stun/seizure, pain perception, decreased spontaneous activity and brain acetylcholine concentration, microwave induced whole-body movements, thermal sensation, startle modification and microwave hearing. These effects are associated with increases in tissue temperature ranging from less than 0.1 °C to more than 40 °C and pulse energy deposition from less than 10 mJ/kg to more than 57,000 J/kg in several seconds or less. The threshold for a single pulse effect appears to have a critical duration for its dependency on specific absorption.

Auditory perception of pulsed RF is the only established specific effect of pulse modulation because CW RFR is incapable of eliciting such response. Other studies on comparison between effectiveness of pulsed and CW RFRs cover a wide range of carrier frequency, modulation characteristics and biological endpoints. Differences found in these studies are usually small, disparate or not replicable. Recent provocative observations are stimulatory effect of pulsed RFR on spontaneous lymphoblastoid transformation in human lymphocytes, increased ornithine decarboxylase activity in L929 murine cells, enhanced growth rate in yeast cells and a greater increase in local skin temperature of humans exposed to pulsed RFR. Studies on carrierless pulses are rather limited at present. Nevertheless, effects in absence of overt bulk heating are delayed hypotension in rats, increased nitric oxide production in RAW 264.7 macrophages incubated in nitrate and more stress vocalizations, longer medial-to-lateral length of hippocampus and decreased mating frequency in male rats. Apparently, current knowledge regarding the effect of pulse modulation needs to be expanded. *This work is supported by a USAMRMC contract, DAMD-17-94-C-4069.*

THE EFFECT OF WEAK ELECTROMAGNETIC RADIATION ON THE GROWTH AND DEVELOPMENT OF LARVAE AND METAMORPHOSIS OF GRAIN BEETLE *TENEBRIO MOLITOR*

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The weak electromagnetic radiation (WEMR) (36 GHz at a power from $0.001 \mu\text{W}/\text{cm}^2$ to $100 \mu\text{W}/\text{cm}^2$, during 10 min) was used to study its effect on the growth and development of the grain beetle *Tenebrio molitor*. The dynamics of weight of the larvae, their length and metamorphosis of pupae in control and experimental groups were investigated. The larvae had been weighed and kept in the electromagnetic field daily or once a week. The average weight of larvae in the experimental groups was less than in the control groups. The inhibitory action of WEMR on larval growth was weak at the power of $100 \mu\text{W}/\text{cm}^2$ and considerably stronger at $0.001 \mu\text{W}/\text{cm}^2$. The effect of WEMR did depend on the season: the differences in weight between experimental and control groups increased by WEMR faster in summer. This difference was stronger when the larvae were affected daily than once in a week. The WEMR had an insignificant effect on the growth of length of larvae. A weak inhibitory effect appeared only after one month of development. The WEMR ($0.001 \mu\text{W}/\text{cm}^2$) inhibited the metamorphosis of pupae. The effect of WEMR at a power $100 \mu\text{W}/\text{cm}^2$ on the postembryonal development differed and it could be either stimulatory or inhibitory.

THE BRAIN INTERHEMISPHERE ASYMMETRY AND ELECTROCORTICOGRAM DESYNCHRONIZATION REACTION DEVELOPMENT INFLUENCED BY MICROWAVES IN EXPERIMENT

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The character of bioelectric brain activity is regularly changed according to the state of an organism. Big hemispheres of human and animal brain are functioning by the asymmetry principle.

Each hemisphere carries its specific contribution and dominates at particular steps depending on the activity form. It is known that activation of the big hemisphere cortex occurs on peripheral stimulation. And desynchronization

tion of electroencephalogram is expressed as an increasing frequency and lower amplitude of oscillations.

In the present work it has been found that the action of electromagnetic waves leads to changes in electroencephalogram, the character of which is dependent on the parameters of electromagnetic waves, and on the functional state of central nervous system.

The brain functions and desynchronization reaction in response to light stimulation under the effect of microwaves have been studied and analyzed.

The experimental investigations of uretanum narcotized rats (1g/kg, intraperitoneally) with a mass of 160-180 g have been carried out. Symmetrically positioned (1-2 days before experiment) electrodes in two hemispheres were used for electrocorticogram recording. The animal head was irradiated by low intensity pulse modulated microwaves (frequency – 42,2 GHz, power density - $150 \mu \text{ W/cm}^2$, modulation frequency – 1Hz). The desynchronization reaction was caused by light irradiation (6000 lux during 5 s). The correlation dimension, maximal frequency, autocorrelation functions have been calculated for each hemisphere separately, and analysis of power spectrum has been performed.

As a result of these experiments it has been revealed that the interhemisphere brain asymmetry was retained, while a level of spectral components was changed. It has been established that microwave irradiation is liable to increase the correlation of interhemisphere activity, to induce synchronization (from the physical viewpoint) in hemisphere functions, that was confirmed by matching of such parameters as correlation dimension, frequency at spectral maxima for the right and left hemispheres. It has been shown that in these conditions the activity of the big hemisphere cortex was facilitated, being manifested as appearance of the desynchronization reaction in electrocorticogram after light stimulation.

Thus, a result of microwave irradiation the changes in the brain activity contributing to the interhemisphere correlations and desynchronization reaction may be observed on light stimulation.

FREQUENCY DEPENDENCE OF EFFECTS OF WEAK ELECTROMAGNETIC WAVES ON MURINE CYTOKINE PROFILE

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In recent years, both the popular media and the science media have raised concerns about the effects of weak electromagnetic waves on the biological

systems. Specific effects induced by exposure of cells to weak microwaves continue to be reported but the mechanisms that underlie cellular detection of microwaves are still not understood.

In the present study, tumor necrosis factor (TNF), well-known as antitumoral cytokine, and also interleukin-2 (IL-2) and interleukin-3 (IL-3) that play the relevant role in a pathogenesis of different diseases, were chosen as the markers of the immune status of cells. The purpose of the present research was to observe *in vivo* and *in vitro* low-intensity electromagnetic effects on the production of mentioned cytokines in peritoneal macrophages and T cells of mice. Concentrations of interleukines were measured by enzyme linked immunosorbent assay (ELISA). TNF concentration was assayed by standard cytotoxicity test, using L929 as target cells.

We have shown that *in vivo* and *in vitro* exposure to 8.15–18.00 GHz microwaves caused the rise of TNF production; the value of stimulating effect was identical for two various populations of secretory cells, macrophages and T lymphocytes. In opposite, 40 GHz microwave exposure of cells *in vitro* induced the noticeable activation of TNF production in the lymphocytes, but not in the macrophages. Moreover, after whole-body 40 GHz microwave irradiation, the levels of TNF production were oscillated from 70% to 200%, according to varied exposure time.

Our findings showed that 8.15–18.00 GHz microwaves manifested themselves as an immunostimulator factor; while 40 GHz microwaves imitated a weak damaging effects. No changes were observed in IL-2 and IL-3 production; so, it could be supposed that interleukines are not involved in the cellular immune response on microwave irradiation. It is true for 8.15–18.00 GHz and 40 GHz microwaves. Thus, TNF plays a key role, among others cytokines, in cellular response to microwave action.

IMMUNOTROPIC POTENCY OF PULSE-MODULATED 1300 MHZ MICROWAVES ON HUMAN IMMUNOCOMPETENT CELLS EXPOSED *IN VITRO*

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The exposure in radiofrequency (RF) and microwave (MW) fields can influence function of the immune system, but the available data on the immunotropic potency of RF/MW radiation are still full of uncertainties and

controversies. It has been stressed that in the available literature there exist no reports on complex assessment of function and responsiveness of the immune system.

To determine potential immunomodulatory influences of low level microwave MW field, isolated human peripheral blood mononuclear cells (PBMC) were exposed to pulse-modulated 1300 MHz microwaves. After exposure microcultures were set up and following functional parameters of T-lymphocytes and monocytes were measured: spontaneous $^3\text{HTdR}$ incorporation, lymphocyte response to PHA and ConA, ratio of PHA and ConA response, monokine influence on lymphocyte proliferation, suppressive activity of T cells and saturation of IL-2 receptors on T lymphocytes. Concomitantly, the samples of cell-free medium removed at 24 hour from non-stimulated cultures were assessed by ELISA tests for concentration of IL-1 β , IL-1 α , TNF α , IFN- γ and IL-10.

The results of our experiments demonstrated that the exposure of cells to the pulse-modulated 1300 MHz microwave field caused measurable changes of some functional parameters of lymphocytes and monocytes.

THE NEUROHORMONAL STATUS AND ENERGY SUPPLY OF TISSUES OF RATS OF BOTH SEXES IN CONDITIONS OF DIFFERENT MODES OF LOW-INTENSITY ELECTROMAGNETIC FIELDS

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The content of catecholamines (CA) in thymic and splenic nerve fibers, corticosterone (CS) in blood plasma, and the tricarboxylic acid cycle (TAC) enzyme activity in brain, myocardial, and hepatic mitochondria were studied under the chronic influence of electromagnetic fields (EMF) in natural and experimental conditions.

The data were obtained on male and female white rats weighing 180–200 g (n=40). In natural conditions the animals were exposed 10 times (4 h daily) to EMF (E=10–15 V/m, H=800–1500 nTl, 50 Hz). The source of the exposure was a high-voltage transmission line of 110 kW. In experimental conditions the animals were exposed to EMF 4 h daily for 5 weeks (in all, 25 sessions at H=2000–2500 nTl). The EMF parameters were measured with HI-3604 (USA) and HI-2218 (Denmark) instruments.

It was found that different modes of EMF did not substantially change the content of CS in blood plasma, CA in nerve fibers of the immune organs, and the activity of membrane-bound TAC enzymes in the brain, myocardium, and liver of mature males. At the same time, EMF significantly decreased CS, CA, and the dehydration rate in the Krebs cycle in females.

Thus, the exposure to low-intensity EMF leads to more marked changes in the neurohumoral status and energy metabolism in tissues of mature female rats in comparison with males. The results indicate sexual differences under unfavorable influences of non-ionizing radiation.

STUDY OF INFLUENCE ELECTRO MEGNETIC FIELDS ON SOME CELLS BIOCHEMICAL CHARACTERISTICS IN VITRO

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Earlier by us (1995, 1998), at study of influence electro-magnetic fields (EMF) on some biochemical and cytochemical parameters of cells it was revealed, that one of the basic targets, determining biological effect is so-called Fe-containing biologically active moleculars, which, as a rule, relate, either to transport, or to metabolism of oxygen in bodies and tissies of organism. In my opinion existing natural planetary, interplanetary and space EMF play the same important role in evolution of flora and fauna as oxygen, water, carbonic gas, macro- and microelements etc., in some times of cases, determining a level of biochemical activity of atoms and molecules of biologically active molecuels, on the one hand, as well as physiological activity of cells, bodies, tissues and systems, with another.

According to received us of the data, has appeared, that than above on an evolutionary ladder there is a kind especially specific influence render EMF, i.e. practically it is possible to influence the various parties of physiological reactions, including intersystem, intraorgans and intracells processes. Depending on intensity, frequency and the durations EM of influence cause as positive (increase of stability of cells and organism to altering to influences, increase of activity, hiperthorophy and reproduction of cells), and negative effects (decrease of activity, stability, distrophy and destruction of cells). As appears from the results, received by us, the most important factor determining biological influence is the frequency EMF and time of influences coordinated with a biological rhythm of researched structure, cells, organs,

tissues or system, when the rather insignificant doses EMF allow to receive the maximal directed biological effect.

EXPERIMENTAL STUDY OF RANA TEMPERARIA'S ISOLATED SCIATIC NERVE RESPONSE TO MAGNETIC FIELD FREQUENCY

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The present work cites the experimental data on changing physiological characteristics of an isolated sciatic nerve of a frog (*Rana temporaria*) in response to the external electro-magnetic field (EMF) frequency ranging within 1–500 Hz (32 frequencies); while the signal shape, amplitude and duration were fixed.

The goal of the work was to investigate how an isolated *Rana temporaria* sciatic nerve responds to EMF exposure dependently upon a certain frequency, amplitude and shape of the signal in the inductor and the signal duration. The EMF range was within low and very low frequencies of interest to us.

The effective potential parameters were studied by way of irritation and registration of bio-electric potentials using external bipolar electrodes in a humid chamber.

During the experiment the following parameters were recorded: effective potential amplitude; velocity of the effective potential front rise; effective potential duration; velocity of effective potential tail attenuation; velocity of the potential propagation through the nerve.

There were found out biologically meaningful EMF frequencies, which cause an articulate oppositely directed action of the effective potential.

The experimental results are of a basic nature and serve as the ground for continuation of EMF bio-effects upon nervous system and organism upon the whole.

THE EFFECT OF ANTRACENE-INDUCED ELECTROMAGNETIC RADIATION UPON THE LACTATDEHYDROGENASE ACTIVITY

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It was stated by our further investigations that the hermetically sealed organic substances including anthracene generate electromagnetic radiation (EMR) of radio-wavelength that makes the distant non-contact action (NCA) upon the biological systems of different level, from molecules to organisms.

During model conditions *in vitro* we studied the NCA of anthracene by mass of 8.1 g (0.05 mM) on the speed of enzyme reaction catalysed by lactate dehydrogenase (LDH). During the experiments we used the LDH suspension (EC 1.1.1.27) from the pork muscle (Reanal, Hungary). The enzyme activity was determined by photometry method on the wavelength 340 nm. The experimental samplers contained the reaction mixture were stated on the hermetically sealed anthracene mass and exposed in thermostat with temperature +30° C. The control samplers were stated on the empty seal and exposed in thermostat also.

In the case of direct reaction (the oxygenation of lactate to pyruvate), the anthracene NCA expressed as the lowering of reaction speed for 18.9% in comparing the control. The reverse reaction speed (from pyruvate to lactate). Quite the contrary grew for 27.8% in comparing the control. The data were reliable ($p > 0.999$). The kinetic investigations fulfilled by us earlier showed that the NCA of aromatic substances provides the reversible changes in apoferritin conformation. At this connection, the fact that the same LDH conformation change effected by anthracene NCA made the contrary action on the direct and reverse reaction is of special interest. Thus, the enzyme reaction on the EMP, generated by anthracene and other aromatic substances essentially depends upon the chemical conditions in which it expresses its catalytic activity (both as the character of its activity).

THE ACTIVITY OF ACIDIC PHOSPHATASE OF A THYROID GLAND UNDER THE INFLUENCE OF THE ELECTROMAGNETIC FACTOR

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In the experiment on white non pedigree male rats the activity of acid phosphatase (AP) of a thyroid gland was studied at 5, 7 and 10-months' EMR influence. The definition of AP contents was utilised for the estimation of intensity of splitting iodinecontaining of thyroid Hormonums from colloid thyreoglobulin. AP was taped on cryostat sections by the method of simultaneous azocoupling (substratum – AC – MK) with the subsequent definition of the value of its activity on the television automatized microdensitometer. The density of the directed currents (DDC) in a body of an animal compounded $2.7 \text{ } \mu\text{A}/\text{m}^2$ and $0.37 \text{ } \mu\text{A}/\text{m}^2$, by the frequency of 50, 100 and 500 impulses p/w (P/w) independently from their division on days and duration of 15–40 ns.

While studying of the material it was defined, that the 5 and 7-months' EMR effect with DDC of $2.7 \text{ } \mu\text{A}/\text{m}^2$ independently from the P/w amount causes the authentic decrease of AP activity. In 10 months the contents of the enzyme appears to be the least, but it's indistinguishable from metrics of an age control level.

In the conditions of electromagnetic factor usage (EM-factors) with DDC $0.37 \text{ } \mu\text{A}/\text{m}^2$ at frequency 500 P/w after 5 months the lowering AP activity is observed, it is succeeded in the subsequent periods by its authentic increase. 5 and the 10-months' exposure with frequency 100 P/w reduces in falling of AP contents. At frequency 50 P/w in all periods of observation the authentic enhancement of AP activity is defined.

Thus, judging by changes of AP activity, the release intensity of iodinecontaining tyreoid Hormonums in the conditions of Em-factor effect decreases at DDC $2.7 \text{ } \mu\text{A}/\text{m}^2$ after 5 and 7-months and is steadied by the closing date of the observation. At $0.37 \text{ } \mu\text{A}/\text{m}^2$ in a frequency dependence P/w and the duration of an electromagnetic radiation predominates either hormonoeduction : 500 and 50 P/w, or depressing: 100 P/w.

SYMPATHOTROPIC EFFECTS OF A PULSE MAGNETIC FIELD IN THE ORGANS OF THE ENDOCRINE, IMMUNE AND REPRODUCTIVE SYSTEMS

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Studies were performed on female guinea-pigs in the series of experiments with a daily 10-min exposure to pulse magnetic fields (PMFs) for 5 and 10 days. In the first two series of experiments maximum induction of PMFs was obtained (1.5 Tl) with pulse frequency 15 per minute and duration of 2×10^{-3} s induced by one solenoid. In the following four series four-solenoid PMF generator was used that allowed to obtain magnetic induction of 1.5 Tl, pulse frequency of 30 per minute and duration of 5×10^{-3} s. Two types of the influence have been approved: a) all four solenoids switched on simultaneously, and b) two paired switching on with a shift of 100 ms. Animals were positioned into a special box between solenoids. Control animals underwent all manipulations except for magnetic influence.

The histochemistry included demonstration of the energy metabolism enzymes succinate dehydrogenase and NADH- and NADPH-dehydrogenase by the unified Lojda method. The sympathetic innervation of the organs was studied with the modified formaldehyde method of Falck.

The state of endocrine system, of sympathetic ovarian innervation, of thyroid and adrenal glands and spleen, and structural and functional parameters of the neurons of the spinal cord sensory ganglia (at L₁-L₂), and inferior mesenteric ganglion (IMG) were studied.

By the 5th day PMFs is induced activation of the adrenergic link of innervation which is known to carry out an important trophic function auditis followed by a complex of changes in transmitter-energy metabolism of neurons of the spinal cord ganglia and IMG, rearrangement in the follicular apparatus of gonads and thyroid. By the 10th trial some features of hyperresponsiveness of adrenergic endings have been established in thyroid and gonads, and functional tension of intracellular organelles of theocytes and folliculocytes.

It may be supposed that biostimulation effect of PMF in the organs is associated with it sympathotrophic action.

THE INFLUENCE OF LOCAL LASER EXPOSURE ON THE PSYCHOPHYSIOLOGICAL STATUS OF RATS

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Last years, sources of laser radiation have been finding the increasing application in biology and medicine. Still, obviously many aspects of laser biotropic effects remain investigated insufficiently. We put a task to assess a possibility of modifying influence of low power laser radiation (LPLR) on functional status of higher departments of central nervous system in rats.

The head (brain area) of the animals was irradiated by LPLR. The area of skin to be exposed was carefully depilated prior to the beginning experiments. As a source of laser radiation, we used a semi-conductor laser LPI-105 (Russia), the wavelength was 890 nm, and the pulse duration was 100 ns.

In the first series of the experiments, the animals were exposed to single 15-min irradiation under modes 1 (2500 Hz, input power approximately 1.0 mW) and 2 (10000 Hz, 5 mW). It was shown that single laser exposure essentially did not change development and reproduction of the conditioned avoidance reflex (CAR) in the shuttle-box.

Further, we applied multiply exposures to LPLR (once per day, for 15 minutes for each 5 successive days). After irradiation under mode 1 slightly greater total number of CARs was registered in experimental rats compared as to the control. As a whole LPLR exposure under this mode causes a moderate stimulation of cognitive function of brain, as though sharpening the reaction of animals and their "ingenuity" in the course of the tests. At exposure to LPLR under mode 2 an expressed stimulating effect on a number of parameters was marked. In particular, an increase of the total number of CARs per session and a reduction of the number of refusals from changing chambers was marked in the trial group of rats.

Evaluating the persistence of the acquired habits, we found that stimulating effect was transitory, and the testing on the 14th day showed that practically all the parameters analyzed in the experimental and control groups were the same.

**MODIFICATION OF EFFECTS OF WEAK
ELECTROMAGNETIC FIELDS ON THE PROLIFERATIVE PROC-
ESSES IN THE RAT THYMUS AFTER APPLICATION
OF LIPOPOLYSACCHARIDE *E. COLI***

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Effects of weak electromagnetic fields (EMF) from a high-voltage transmission line (110 kV) on the proliferative processes in the thymus of white male rats (170–200 g) were studied in natural conditions. The first group of animals was exposed 10 times (4 h daily) to EMF with the predominant magnetic component (electric field 10–15 V/m; magnetic induction 800–1500 nTl). The second group was treated 15–20 min before the exposure to EMF with lipopolysaccharide (LPS) *E. coli* (intraperitoneally, 5 times every other day, 25 ug/kg). The third group received LPS similarly as the second group. The control group was injected with saline. The last two groups were kept at some distance from the radiation source.

In a day after cessation of experimental exposures the activity of the initial pentosephosphate cycle enzyme glucose-6-phosphate dehydrogenase (G-6-PDH) and the DNA synthesis in lymphocytes of the thymus were determined. It was found that 5 injections of LPS led to an inconsiderable increase in the G-6-PDH activity in the thymus, whereas in conditions of prolonged action of weak EMF the stimulatory effect of this agent on the enzyme activity was not detected.

Multiple exposure to EMF led to an inhibition of the DNA synthesis in a lymphocyte culture stimulated by the T mitogen concanavalin A (2 ug/kg). At the same time, application of LPS to EMF-treated animals prevented a decrease in the proliferative activity of thymocytes. Hence, effects of 5-fold application of LPS *E. coli* and of weak EMF on the functional state of lymphoid cells of the thymus are not observed in case of the combined use of these experimental exposures.

THE MICROWAVE INFLUENCE WITH INTENSITY OF 1 mW/cm² ON DYNAMICS OF PREGNANT RATS WEIGHT.

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The aim of this work was to investigate the microwave influence on pregnant rats weight indices dynamics. In connection with this from the thirteenth till the eighteenth days of pregnancy the rats were irradiated by microwaves 2450 MHz of constant generation with the intensity of 1 mW/cm² during 8 hours a day. During the influence the animals were in special radiotransparent pens, which allow to exclude their moving relatively to vectors of electromagnetic field (EMF) and to create the stability of energy absorbing. The longitudinal axis of rats was parallel to magnetic vector of the farthest zone of electromagnetic waves, at the same time the level of specific absorbing power was 0,2 W/kg (Durney C.H., e.a., 1978). The results comparison was conducted between the test group, imaginary irradiation (I I) and biological control (BC). Weight indices of intact animals are very stable and for 30 days of investigation are not higher of 0,3 % from the initial level. As the experimental results showed, in all the groups weight increase exceeded this value from 5-7 days of pregnancy. Influence evaluation criterion was relative weight increase and relative weight increase rate. Indices comparison was conducted according to the criteria of 2 processes significance evaluation (Plochinskiy N.A., 1970). As the experiment results showed, the significant differences of processes were between the test group and BC beginning with the 12-th day of pregnancy. We didn't see the significant differences between medium levels of processes between test group and I I. In BC group the relative weight increase, exceeding 0,3 %, began from the 5-th day of pregnancy, and in other groups - with the 7-th day. This lag from BC was during the whole experiment. But according to the received mathematical model I I group nearly caught BC. In general, weight relative increase dynamics in all the groups had parallel character, it was seen in the absence of differences of relative rate of weight increase. So, the fact of microwave influence with the intensity of 1 mW/cm² on pregnant rats weight indices isn't found.

4. EMF MOBILE COMMUNICATION AND THE INVESTIGATION OF DANGEROUS

CAN CELLULAR PHONES BE SUSPECTED OF DELETERIOUS EFFECTS ON CHICK EMBRYOS?

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The aim of the present study was to conduct a reliable replication, in chickens, of a recently published experiment on the effects of electromagnetic radiation emitted by cellular phones during embryo development (M. Bastide, B.J. Youbicier-Simo, J.C. Lebecq, and J. Giaimis, *Indoor Built Environ.* 10, 91–98; 2001).

The first objective was to standardize the conditions of incubation so that, in absence of cellular phone, the overall performances obtained in the experimental chamber become repeatedly similar to those observed in a standard hatchery.

In a series of seven replicates, eggs issued from artificially inseminated hens (200×10^6 spz) were placed on a polystyrene plate and then incubated in an incubation chamber itself built with materials devoid of metallic content. Eggs were maintained at $38 \pm 0.5^\circ \text{C}$ and hygrometry varied at extremes between 40 and 49%. Eggs were turned and candled every other day during the incubation.

Our preliminary results revealed some difficulties to obtain repeatedly high rates of embryo survival after 11–13 days of incubation. Once this question circumvented, chick embryo will be permanently submitted to electromagnetic fields issued from a mobile phone placed on the incubation plate in “call” position. Temperature, hygrometry, length of the calls, and electromagnetic field will be controlled during all the incubation.

**RUSSIAN MINISTRY OF PUBLIC HEALTH PROGRAM FOR
INFORMATION SUPPORT OF POPULATION SAFETY PROBLEM
IN CONDITION OF MOBILE TELECOMMUNICATION
EMF EXPOSURE.**

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The Working Coordination Group of the Russian Ministry of Public health “Mobile telecommunication electromagnetic safety” was organised according to the Russian Federation Chief state doctor’s order № 581Y in April 11, 2002. The working group aims to improve the organisation and methods of the state epidemiological control in Russian Federation, for realising of the interdepartmental meeting “Population safety in conditions of mobile telecommunication EMF exposure. Information providing and state sanitary epidemiological standardisation” decision. The Group consists from the Russian Ministry of public health and several profile scientific organisations representatives. Working group have prepared and presented the “Program for the study of mobile telecommunication safety problem and population information support”.

The main aims of the “Program...” are:

- population health protection in condition of rapid development of mobile telecommunication;
- EMF standards and state inspection improvement;
- improvement of the state epidemiological inspection system, using modern scientific data, technological innovations and information technologies;
- rational usage of scientific results and research organisations potentials;
- assistance to the development and inculcation of safety mobile telecommunication equipment;
- organising of effective cooperation and understanding between government, population, mobile telecommunication equipment / services manufactures and provider;
- participating in the international EMF standard harmonisation process (WHO International EMF Project) to simplify mobile telecommunication products and services transmission between countries;
- unification of hygienic requirements to EMF before Russia entrance to WTO;

- development of non-ionising radiobiology and hygiene on the basis of methodological, technological and international requirements to research process;

The most important direction of the “Program ...” is population providing by the objective scientific information due to mobile and wireless telecommunication hygiene.

EXPERIENCE OF EMF INTENSITY INSTRUMENTAL CONTROL FROM CELLULAR RADIO NETWORK BASE TRANSCEIVER STATIONS IN MOSCOW REGION

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Today base station transceiver (BTS) of cellular radio network became the most spread stationary technogenic sources of radio frequency electromagnetic fields (RF EMF) in residential areas. At the end of 2001 in Moscow there were about 2300 BTS, i.e. about 2–3 BTS per square kilometer. The increase of BTS stipulated by significant rise of subscribers number and desire to improve the services quality by providers.

BTS is the quite specific RF EMF source. Average transmitting power depends on number of mobile station located in BTS services zone and so depends on day time, week day, season and etc. Such situation leads to sufficient time-frequency RF EMF fluctuations and regular changes of conditions of human body electromagnetic exposure. Therefore current instrumental control of electromagnetic situation in correspondence with Russian methodical guidelines (measurement of the highest BTS radiating power) is very hardly realized in practice, especially in places with several BTS.

It is known, that BTS theoretically are possible to expose RF EMF exceeding the maximum permissible levels for non-professionals exposure category in uncontrolled environment. Besides, transmitting BTS antennas (very often several ones) are mostly fixed on buildings (dwelling, hospitals, schools). Cases with using of separate specially made for BTS masts occur very seldom. Such situation in combination with absence of reliable information about electromagnetic situation cause the social conflicts between population living near the BTS and providers, regional governments, state sanitary and epidemiological inspection organs. Development of such opposition demands to carry out the independent sanitary and hygienic /ecological expert estimation.

Specialists of test laboratory of Center for electromagnetic safety regularly measure RF EMF intensity from BTS, especially in uncontrolled environment at the aim of sanitary and epidemiological control. Electromagnetic situation of territories surrounding 181 BTS was researched at the period of 1997–2002. Instrumental control have been realized in correspondence with the Russian and the International standards. RF EMF measured by broad-band instruments (of Russian and foreign production) at different BTS work mode, including the test mode (artificially made mode of maximum intensity). BTS work was controlled by scanning receiver. Particularity of this method is that the targeted search of EMF excessive levels was made.

Measurement results analysis allows to conclude that in all EMF control points in uncontrolled environment – in buildings, surrounding territories, RF EMF intensity haven't exceeded the maximum permissible level for this frequency range. In the majority cases values were not more than $1 \mu\text{V}/\text{cm}^2$. The contribution in the electromagnetic situation RF EMF exposed by radio-relay station of BTS for integration in working network was negligible. Absolutely all researched BTS have no so called safety zones.

According to realized researches we could conclude, that today BTS from the electromagnetic safety position are not the objects, needed for careful attention. It is necessary to organize population education for social conflicts prevention.

USING OF MOBILE PHONE ELECTROMAGNETIC FIELD AS A CONDITIONAL STIMULUS FOR ANIMALS IN LEARNING PROCESS

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Labyrinth thirsty conditioned reflex at 10 non-breeding rat-albinos was developed. EMF from mobile phone (900 MHz, $E=16\text{--}22 \text{ V/m}$, $H=0,05\text{--}0,075 \text{ A/m}$, exposure time 15-20 sec.) was used as a conditional stimulus. Exposure installation consisted of the mobile phone (Siemens C25, GSM–900), connected with amplifier (Remotek RP5-GSM, gain 20 dB) and antenna (mono-pole $3\lambda/4$, gain 2 dBi). The control animal group was learned to thirsty labyrinth conditioned reflex to the light stimulus (lamp 100 W).

After 260 training probes experimental animals have run to the aimed camera by random mode, regardless of conditional stimulus. 80-100 % of control animals had the adequate reaction approximately after 90 probes. At the generalization stage EMF influenced on the learning process to labyrinth conditioned reflex on the place. Number of adequate reaction in the experimental group during the fourth learning session reliably ($p < 0,05$) differed from the control one. The wide variability of probe numbers, necessary for reaching the first aimed criteria was observed at the experimental group. So, 16 % of rats were needed above 40 probes, 33% less than 9 probes. This fact could point to the different direction of EMF influence on learning speed process to place conditioned reflex.

In this experiment the conventional reflex on EMF wasn't developed. Therefore, we could suggest the significance of EMF exposure especially on the first stage of learning process for the integrative behavior of some animal populations.

THE IMPACT TRAITS OF THE ELECTRO-MAGNETIC FIELDS OF THE CELLULAR PHONES ON ITS USERS

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The intensive growth in mobile radio communication means causes a considerable boost in electromagnetic field values to which adverse workings an ever-growing number of population is being subjected to.

The undertaken research has tasked itself with evaluation of the electromagnetic radiation produced by the cellular phones as causing the temperature shifts and functional condition change in the Central Nervous (CNS) and Cardiovascular Systems (CVS) of their users.

The functioning of the cellular phone is evidently accompanied by the statistically positive rise of the skin and ear membrane temperatures in the area immediate to the phone's antenna, which, as a number of authors maintain, reflects the rise in the temperature of hypothalamus.

The head skin temperature with the cellular phone users positively increases by 2.4° C ($P < 0.001$) during the first minute of the conversation, 3.4° C at the end of the second and 4.7° C well into the third minute as compared to the mean temperature values with the people that had the phone off.

Thus the largest growth of the temperature quotient was registered 2.4°C while in work to that of the turned off phone during the first minute of its use. The second and third minutes of the use yielded 1.0° and 1.3°C outcome respectively.

The head of the user is being affected most notably in the immediate area of the phone's antenna.

The functioning of the cellular phone is accompanied by the statistically reliable changes in the CNS and CVS values. The fusion flicker frequency reaction and visual motion reaction intervals increase, while the T-wave amplitude decreases.

The value and the manner of the physiological shifts in using the cellular phones only go to show how intensified herewith the organism's adaptation pattern gets.

EXPERIMENTAL STUDY OF MODULATED ACCORDING TO CELLULAR COMMUNICATION STANDARDS ELECTROMAGNETIC FIELD BIOLOGICAL EFFECTS

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With the purposes of determination of a threshold of modulated according to cellular communication standards EMF harmful effect in the specially designed setup were carried out the experimental researches (in rat) on study of level-temporary dependences of biological effects of modulated (according to NMT and GSM standards) 450, 900 and 1800 MGz (PD – 0.5 and 2.0 mW/cm^2 ; 1 h/day; 40 days; 2-week period after exposure).

Significant influence of EMF exposure to changes of rat body weight gain and character of changes of free behaviour of rats (on a parameter entropy of a mink reflex) was not revealed, that testifies that on these parameters the threshold of harmful effects can be at more high EMF levels.

The research of processes cell differentiation and proliferation in eye crystalline lens epithelium has revealed the dependence from intensity of mitotic activity reduction.

The researches of immune system state have revealed the greatest biological efficiency of 900 MHz frequency (that coincides with results of mathematical modeling), and under interrupted (as additional disadaptated) character of exposure have allowed to reveal of significant change of pa-

rameters of specific and not specific immunity not restored through 2 week after the termination of exposure with 0.5 mW/cm^2 power density, that testifies to high sensitivity and information significance of immune system parameters at study of modulated EMF effects.

In conclusion for the intensity close to a threshold of adverse influence of EMF modulated according to standards of mobile cellular communication, preliminary, the intensity equal to 0.5 mW/cm^2 is accepted, taking into account interrupted principle of mobile phone usage.

EFFECTS OF MOBILE PHONE RADIATION AND DAR PROTECTIVE UNITS ON PLANARIA REGENERATION PROCESSES.

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This document covers the results of the experiment on testing efficiency of units designed by SC DAR in 2002.

The aim of this work is to study the effect of mobile phones' radiation (Motorola M3688 model) on regeneration in planaria (**Dugesia tigrina**). The planaria bodies were dissected across just behind the head blades. Usually, a regeneration bud appears at the place of dissection in three days. Later, it grows up and forms regenerating body parts. Two series of experiments were conducted.

Petri dishes containing planaria were placed above the mobile phones antennas at a distance of 5 sm. The DAR units were placed below the antennas. Mobile phones were on in the call-in mode (1800 MHz, maximal energy fluence rate was equal to $120 \mu\text{W/cm}^2$ at the call set-up moment, and to $50 \mu\text{W/cm}^2$ during rest of the time) for three days after planaria dissection (60 minutes per day with 90 sec exposure time in each session). Then the size of regenerating part was measured and assessed relatively to the planaria length.

The following certain conclusions can be drawn:

1. Mobile phone radiation decelerates regeneration rate by three times (first experiment, $p < 0.01$). In the second experiment 100% planaria death-rate was registered.

2. DAR units reduce the effect of mobile phone radiation by 2 times (first experiment, $p < 0.01$). In the second experiment 40% planaria death-rate was registered ($p < 0.01$).

3. DAR units' effectiveness depends on their construction.

Their effect is caused by reflection of incident electromagnetic radiation by structured conducting medium, which produced a standing wave of a particular spectrum range and, consequently, combined action of original and reflected EMFs.

EFFECTS OF MOBILE PHONE RADIATION AND DAR PROTECTIVE UNITS ON EARLY DEVELOPMENT OF ANOUROUS AMPHIBIA

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The inseminated spawn and larvae of *Xenopus laevis* (Daudin) was chosen as the object of this study.

The table of *Xenopus laevis* normal development (Niewkoop, Faber, 1956) was used for precise estimation of embryonic and larval phases.

The individuals matched for size at the neurula development phase were selected for experiments on embryos because this phase is most susceptible to external influences.

This document covers the experimental results of testing of efficiency of three different DAR unit models designed by SC DAR in 2002.

Petri dishes, containing 53 larvae each, were placed above the mobile phone antennas at a distance of 5 sm, and the DAR units were places below the antennas. Mobile phones were on in the call-in mode (1800 MHz, maximal energy fluence rate was equal to $120 \mu\text{W}/\text{cm}^2$ at the call set-up moment, and to $50 \mu\text{W}/\text{cm}^2$ during rest of the time) for three days (60 minutes per day with 90 sec exposure time in each session).

The state of the larvae was controlled every day. Dead individuals were removed, and developmental phases of other larvae identified in both the experimental and reference groups.

The resalts of the study show that a significant difference between experimental and reference groups after the first day of mobile phone exposure (delay by 2 stages, $p < 0.01$). The effect of delayed development remained unchanged on the second and third day of the experiment as well.

The significant protective effect had only one of the DAR unit(absence of delay in development) suggesting its dependence on the design of the unit.

This work was supported by SC DAR in 2002.

DAR PROTECTIVE UNITS EFFECT ON EARLY DEVELOPMENT IN ANOUROUS AMPHIBIA

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The inseminated spawn and larvae of *Xenopus laevis* (Daudin) was chosen as the object for this study.

The table of *Xenopus laevis* normal development (Niewkoop, Faber, 1956) was used for precise and accurate estimate of embryonic and larval phases.

The individuals matched for size at the neurula phase were selected for the study because this phase is the most susceptible to any external influence. Abnormalities can be easily detected by such parameters as delay in embryonic development, developmental synchronism abnormality, increased embryo death rate, etc.

This document covers the experimental results of testing of efficiency of three DAR unit models designed by SC DAR in 2002.

Petri dishes, containing 53 larvae each, were placed above a DAR unit at a distance of 5 cm for 60 minutes per day during three days.

The state of larvae was controlled every day. Dead individuals were removed, and phases of development of other larvae were identified in the both the experimental and reference groups.

During studying of possible influence of the protective unit on early Amphibia development (without mobile phone) the following results were obtained:

On the first day of the experiment, a significant difference in the rate of development was found between reference and experimental groups (the experimental group was affected by protection unit only) with superiority of the experimental groups (2 stages, $p < 0.01$). On the third day of the experiment the effect was detected only in two experimental groups suggesting its dependence on the design of the unit.

EFFECTS OF MOBILE PHONE RADIATION AND DAR PROTECTIVE UNITS ON PLANARIA REGENERATION PROCESSES

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This document covers the results of the experiment on testing efficiency of units designed by SC DAR in 2002.

The aim of this work is to study the effect of mobile phones' radiation (Motorola M3688 model) on regeneration in planaria (*Dugesia tigrina*). The planaria bodies were dissected across just behind the head blades. Usually, a regeneration bud appears at the place of dissection in three days. Later, it grows up and forms regenerating body parts. Two series of experiments were conducted.

Petri dishes containing planaria were placed above the mobile phones antennas at a distance of 5 sm. The DAR units were placed below the antennas. Mobile phones were on in the call-in mode (1800 MHz, maximal energy fluence rate was equal to $120 \mu\text{W}/\text{cm}^2$ at the call set-up moment, and to $50 \mu\text{W}/\text{cm}^2$ during rest of the time) for three days after planaria dissection (60 minutes per day with 90 sec exposure time in each session). Then the size of regenerating part was measured and assessed relatively to the planaria length.

The following certain conclusions can be drawn:

1. Mobile phone radiation decelerates regeneration rate by three times (first experiment, $p < 0.01$). In the second experiment 100% planaria death-rate was registered.

2. DAR units reduce the effect of mobile phone radiation by 2 times (first experiment, $p < 0.01$). In the second experiment 40% planaria death-rate was registered ($p < 0.01$).

3. DAR units' effectiveness depends on their construction.

Their effect is caused by reflection of incident electromagnetic radiation by structured conducting medium, which produced a standing wave of a particular spectrum range and, consequently, combined action of original and reflected EMFs.

PHYSIOLOGICAL ESTIMATION OF CARDIO-VASCULAR AND NERVOUS SYSTEMS PARAMETERS AT USAGE OF CELLULAR PHONES. VOLUTEERS RESEARCH

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In research on 25 volunteers (14 men, 11 women) estimated the temperature in area of ear antitragus, the state of cardiovascular system (by parameters of blood pressure, heart rate, variational pulsometry) and nervous system (by speed of visual-motor reaction, critical frequency of merge and distinction of light flashes) before and after real (18 men) or imaginary (7 men) usage of cellular phone (GSM standard) with electromagnetic field (EMF) power density levels 40–80 $\mu\text{W}/\text{cm}^2$.

On a background high individual variability of all estimated parameters of cardiovascular and nervous systems it is not revealed of their deviations abroad of physiological norm both up to, and after real or sham EMF exposure from cellular phone.

Is not revealed statistically significant differences between estimated parameters:

- Before and after sham EMF exposure from cellular phone,
- Before and after real EMF exposure from cellular phone,
- Before sham and before real EMF exposure from cellular phone,
- After sham and after real EMF exposure from cellular phone.

Thus, unitary 30-minute EMF exposure from cellular phone didn't result to significant changes of evaluated parameters of cardiovascular also of nervous systems, testifying about absence of adverse effects.

ELECTROMAGNETIC DOSIMETRY OF MOBILE PHONES

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Electromagnetic dosimetry of mobile phones, as recommended by European Commission and IEEE, is done through calculation and measurement of value of Specific Absorption Rate (SAR). The measurement has been performed by a system comprised of a three-axes isotropic electric field probe and a three axes positioner. Such a system performs a real-time high-frequency electric field sampling in a homogeneous liquid - dielectric

with losses, that simulates human tissue. The liquid in the phantom has been mixed with the simplest ingredients: different percentage of NaCl, sugar and water. The properties of the phantom have been measured by open coaxial probe. After measuring the properties and checking whether they comply with the required values of CENELEC EN 50361, the measurements of electric field have been performed in the flat phantom, that provides the closest-spacing condition.

After acquiring measured values of electric field in the phantom, the SAR peak values have been calculated by using interpolation algorithms. After this measurement, spatial E-field distribution is measured in the cubic area, centered with the peak SAR location, with the dimensions of at least 1,5 times the length of a 1-g or 10-g cube edge, or 15 mm and 32 mm respectively. For a sufficient interpolation and extrapolation accuracy, horizontal grid spacing should be less than 8 mm and vertical less than 5 mm. The required 1-g and 10-g averaged SAR values are calculated using interpolation and extrapolation. Finally, the relative uncertainty in SAR due to post-processing methods has been determined by using reference data and reference SAR distribution functions. The expanded uncertainty (95 % confidence level) of the whole system is calculated to be 19.3 %.

1. CENELEC, EN 50361: «Basic standard for the measurement of Specific Absorption Rate related to human exposure to electromagnetic fields from mobile phones (300 MHz – 3 GHz), 2001
2. IEEE SCC 34, *DRAFT* Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques, 2002

FREE-WILL AND FORCED RISK OF ELECTRO-MAGNETIC RADIATION IMPACT OF CELLULAR RADIO SYSTEMS

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Risk for a man's life may take two forms – free-will and compulsory (forced) risk. The criteria of relating it to one of these forms are methodically conditioned awareness and agreement of a person to have or not to have additional burdens or impacts being dangerous for Ms/her health and life. At the present moment it is difficult to speak of possibility to reduce EMR level to the

natural one. The main goal of electro-magnetic security system is maintenance of the acceptable level of electro-magnetic fields impact being dangerous for a man's life, and compensation for a damage. Individual life risk has to be chosen by a person voluntarily. Individual electro-magnetic risk may be forcedly rationed only at the stages of childhood and reproduction. At the stages of social activity of a person individual technogenic risk has to be chosen voluntarily and independently - there is a freedom element of a person in this. The society is obliged only to determine this risk and warn a person of potential danger

While regulating forced risk the preferable methods should be normative, administrative and economic mechanisms; while regulating free-will risk enlightening methods should be preferred. It is necessary to move focus of attention from administrative regulatory measures to economic and enlightening ones.

A typical source of free-will risk is a radio telephone carried by a person; a typical source of forced risk is a base cellular radio station. Taking into consideration the fact that the main objective of electro-magnetic security system is turning forced risk into free-will one, at the present moment it is necessary to establish technical requirement to cellular telephone allowing the owners of a telephone to choose and control independently EMR level, that is to use their right to choose voluntarily risk level acceptable for them.

We may formulate the following main statement which are necessary for realizing the principle of free-will risk of a cellular telephone user:

- the user has to know the EMR level of a radio telephone (including the network search mode) and to be warned against its possible negative impact on Ms/her health;
- the user of a radio telephone has to be warned against the danger of using a radio telephone by children and pregnant women;
- the user of a radio telephone has to be able to control EMR and telephone exposition level;
- the user of a radio telephone has to be able to limit Ms/her telephone power independently (including the network search mode);
- the usage of a radio telephone in crowded places should be restricted;

In the report different variants of realizing the principle of voluntariness with radio telephone operating in network search mode and in waiting mode are examined. The above-stated general approach to systematization and evaluating EMR negative impact of cellular radio is supposed to be used while working out corresponding normative-technical documents and making management decisions. The conception proposed does not anticipate administrative restriction of radio telephone power.

5. HYGIENIC PROBLEMS OF EMF EXPOSURE. OCCUPATION PATHOLOGY

RESULTS OF MEDICAL EXAMINATION OF PERSONNEL AT A MOSCOW AMBULANCE CENTRE

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In order to establish the cause of terminal cancer in three women working at a Moscow ambulance station we carried out a series of medical tests on centre personnel. The focus was on seven readings at a total 35 locations within the centre: geomagnetic field, magnetic and electrical fields in the 5–2000 Hz and 2–400 kHz range, microwave electromagnetic fields in the 0.3 to 400 GHz range, magnetic field impulses, static electricity (polarity, potential and induced charge decay period).

The 64 personnel examined (aged from 28 to 40) displayed the following abnormalities:

- signs in the spinal column of early osteochondrosis and chondropathy – 90%
- dysfunction of thyroid glands – 88%
- poor state of immune system giving use to risk of malignant tumours and reduced immunity to infection – 85%
- problems with gastrointestinal tract – 78%
- problems with reproductive organs – 65%
- dysfunction of cardiovascular system – 40%
- general problems affecting response and capacity for work – 74%

Only two individuals (employed for less than a year) displayed a satisfactory state of health.

As a result of responses by personnel to questions regarding working conditions and the degree of comfort experienced at their place of work, together with readings taken, we were able to establish significant harmful factors which we believe combined to impair the health of those who died.

- A halving of the intensity in the geomagnetic field around the area of head and legs as a result of the metal screen on the control panel.
- The positive charge and high potential of static electricity in the floor covering, which displays a long induced charge decay period of 50 seconds.
- A magnetic field or an intensify of more than 0.55 A/m, registered in the 5–2000 Hz range, created by the current running through a cable beneath the floor.

The results of our complex analysis show that prolonged exposure to these factors over a period of several years can lead to a breakdown in the immune system, creating a high risk of malignant oncological processes.

A set of requirements are being developed to provide more satisfactory working conditions, as well as a means of monitoring those conditions and protecting personnel from the harmful effects of the factors mentioned above. The result will be a set of recommendations for the planning out of safe places of work.

SCIENTIFIC AND PRACTICAL SIGNIFICANCE OF THE RIGHT CHOICE OF HYGIENIC STANDARDIZATION PARADIGM

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The practical significance of right choice of the safety standard is obvious. In the sphere of Wien radiation standardization it is not problem, but in the Rayleigh-Jeans radiation standardization the situation is complicate because of the Cheshire cat phenomenon, which is integral part of the boundary of endergonic and exergonic processes [1]. The Cheshire cat phenomenon is the key feature of the isothermal energy conversion in Rayleigh-Jeans region because of the sharp dependence of process efficiency on absorbed power and sharp change-over from exergonic process to endergonic one.

The practical consequence of that is the simultaneous study of endergonic and exergonic processes by the experimentalists and the null effect as a finished experimental result. That is base for the standardization of only thermal effect in USA and 1000-fold difference of Soviet and American standards of microwave radiation. The nonequilibrium thermodynamics laws confirm the rightness of the Soviet (Russian) hygienists [2].

Since the existence of two paradigms are long, now it is obvious the scientific significance of Russian paradigm. It allowed to discovery two new phenomena of great importance (the frequency-specific bioeffects of microwave radiation and the Saratov phenomenon).

1. Reiter R.J. – Modern Radio Science, Oxford University Press, 1999, p. 287–307.

2. Chukova Yu.P. – Advances in nonequilibrium thermodynamics of the systems under electromagnetic radiation. – Moscow, Khrizostom, 2001, ISBN 5-7508-0285-X.

SOCIAL-ECONOMIC COMPONENT OF ELECTROMAGNETIC IR-RADIATION TECHNOGENIC RISK.

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Electromagnetic irradiations (EMI), as physical factor of professional performance and environment, is not simple social-hygienic problem, the importance of which in the system “operator-machine” is constantly increasing. In the evaluation of EM-factor there are many components: dosimetric, medical-biological, normative-legal, economical, social-psychological. The last two components are of great interest for public. There are 3 possible causes of risk: the absence of technical and biological mechanisms of adaptation to danger; hardly probable danger; expensive defence. The last variant of risk assumption is based on the principle “risk-cost”. The evaluation of risk at decision taking is the important component of management psychology. But, besides internal managing risk, there are risks, connected with external influences. They influence the somatic health of managing personnel and behaviour psychology relatively to these risks. Not to take into account this fact-means to exclude from “man-machine” system one element—the level and adequacy of technogenic and ecological risks perception. The effect of inadequate risk perception is phobias, which don't contain real threat, appearing only in definite situations and sometimes having character of “epidemics”, what is connected with fear increase before technogenic and ecological risk. It's syndrome of unfavourable growing old society, increasing in the periods of social-political unstability. The risk concept may be social problem, when it does not contradict the main social and moral-ethical postulates of society. The absence of possibility to use modern technologies, based on EM-factor, may have negative consequences for society. So, EMI setting must be taken into account by the society only as the concept “harm-use”.

COMBINED INFLUENCE OF ELECTROMAGNETIC FIELD & INDUSTRIAL NOISE ON WORKER'S ORGANIZMS OF THERMOELECTRO MAIN

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The study of human organism reaction on combined influence of electromagnetic field (EMF) and industrial noise (IN) in conditions of production is considered to be one of the priority-driven directions of Labor Medicine.

In the current work the research results of EMF and IN influence on blood pressure (BP) of workers in condition of the present industry are introduced. With this aim, 190 males were selected without any complaint of cardiovascular system. All 190 mails were divided into 3 groups depending on the influence factors intensity. Group 1 – industrial noise above 85 decibel, EMF with 50 cycles per second: number of workers 91 with 499 metrology, middle age 43.9 ± 0.6 . Group 2 – industrial noise below 85 decibel, EMF with 50 cycles per second: 50 workers, 298 metrology, middle age 49.6 ± 0.7 . Group 3 – industrial noise below 85 decibel, absence of EMF: 49 workers, 270 metrology, middle age 54.9 ± 0.6 .

The workers were additional divided by categories of age: from 20 to 29, from 30 to 44, from 45 to 59, 60 and higher. Average value of the age was equal for all groups. Influence of the noise above 85 decibel is registered in the age group of 49–59 on systolic BP (SBP), diastolic BP (DBP), and middle index of BP (BPm). Statistically reliable difference exits between value of SBP, DBP and BPm between 1 and 2, 1 and 3 groups. In the age of 60 and above, difference in the value of SBP and BPm exists between 1 and 2, 2 and 3 groups. Therefore, in this group EMF with 50 cycles per period prevail. Though, noise above 85 decibel and EMF influence on DBP, because the difference of DBP in 1 and 2 groups is $45 \text{ mm Hg/p} - 0.042/$.

Industrial noise above 85 decibel may result in the increase of BP of the workers of 45–59 years of old. EMF of 50 cycles per period may bring about the increase of BP in the age group of 60 and above. Noise above 85 decibel in combination with EMF has more influence in the age group of 60 and above.

HEALTH OF THE PEOPLE WORKING UNDER CONDITIONS OF INCREASED ELECTROMAGNETIC RADIATION

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The goal of this work has been to establish dominant changes in the state of health of the personnel working under conditions of nonionizing radiation depending on the length of service.

The report provides the data on the state of health of 42 people working under conditions of increased electromagnetic radiation (32 men, 10 women).

In 3 cases the changes took the form of vegetative-vascular dystonia. Hypertensive disease was found in 4 cases (the length of service being more than 10 years; the age – 55, 61 and 63 years old). Examination of 32 people has revealed deviations on their EKG in the form of syndrome of early ventricle repolarization, left heart ventricle hypertrophy, intraventricular blockade and ventricular extrasystoles (7 people with the length of service being less than 5 years, 4 people – less than 10 years and 21 people – more than 10 years).

Changes in the blood system took the form of erythropenia for 21 people including 9 women. In 7 cases platelet level was determined as $190\ 000$ (for people with the length of service being more than 10 years). Platelet level varied from 5.0 up to $7.8 \times 10^9/l$ for people with the length of service being less than 5 years; from 5.0 up to $7.0 \times 10^9/l$ for people with the length of service being 5–10 years; and from 4.4 up to $6.9 \times 10^9/l$ for people with the length of service being more than 10 years.

Thus it has been proved that common deviation for all the people being examined is that in nervous, cardiovascular and haematogenic systems. Frequency of deviations found increases with the increase of the length of service. There has been discovered stronger sensitivity to microwaves of erythrocytal appendix compared to those of plateletal and leucocytal ones.

IN VIVO STUDIES RELEVANT TO RF EXPOSURE AND HEALTH

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This presentation will describe in vivo studies in the Western literature that are examples of published reports useful for risk assessment of human exposure to radiofrequency (RF) fields. The International Agency for Research on Cancer (IARC) plans to evaluate RF emissions as a potential human carcinogen in 2004 or 2005. The IARC review is a weight-of-evidence approach that uses all available scientific information, i.e., epidemiological, in vivo and in vitro data and mechanisms of interaction. In such an evaluation, epidemiological studies are most important because these studies provide information on human populations. When epidemiological studies are weak or not definitive, the risk assessment relies heavily on animal studies. In vitro studies, however, generally have a supporting or clarifying role only in these evaluations. Information on mechanisms of interaction is important because this information addresses the biological plausibility of reported biological and health effects associated with exposure to RF energy. After IRAC completes the evaluation of the cancer literature, a similar evaluation of the literature on other biological effects, including reproductive, development and behavioral effects, is planned by the World Health Organization (WHO). Both risk assessments will be based on biological effects that have been replicated or have confirming or supporting data in published literature from independent researchers. Currently ongoing research projects include a number of replication studies and this presentation will include a summary of these replication studies and other in vivo research in progress.

There are a number of long-term, low-level exposure studies of laboratory rodents that are useful for risk assessment. In some studies, RF exposure occurred during prenatal life and continued for two years, the average lifetime of rats and mice. Many of these studies were performed under Good Laboratory Practices (GLP) and met the highest requirements for laboratory studies that provide information for risk assessment. The endpoint most often investigated in these chronic exposure studies was cancer. The results showed that the weight of evidence in the published literature does not support an association between RF exposure and cancer. Furthermore, a number of these studies collected survival data and these results showed that low-level RF exposure had no adverse effect on lifespan of chronically-exposed rats and mice. The results of these studies provide evidence that chronic exposure to low-level RF energy does not cause life-shortening diseases including cancer.

BIOLOGICAL EFFECTS AND SUBSTANTIATION OF HYGIENIC RULES OF ELECTROMAGNETIC PULSES

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With the purpose of an establishment of a threshold of harmful effects of the pulse electromagnetic fields generated by large-sized electric discharge installations (EDI) (seldom repeating η -sec pulses with the maximal intensity of an electric field $E = 12$ kV/m, magnetic field – 40 A/m), and substantiation of their hygienic rules clinical-physiological inspection of the personnel serving such installations and researches of effects of their exposure to animals in conditions of experiment are carried out.

The profound medical inspection of a state of health and serviceability of 191 men (91 persons from group of the personnel serving EDI (up to 100 pulses per one week), 100 persons – the control) with use clinical-psychological, electrophysiological, medical-statistical, psychophysiological, functional and biochemical methods has revealed at the personnel serving EDI, increase of disease rate, attributes astenic-vegetative symptoms, infringements in cognitive and emotional sphere, reduction of physical serviceability and performance activity with increase of professional experience more than 5 years.

Experimental researches on 510 rats – male (including 2 controls) within 10 months were estimated the effects of pulses with E 600, 270, 130 and 50 kV/m on 500, 100 and 50 pulses per one week (0.5–1 μ s duration of a pulse, 20–50 η -sec duration of front of pulses, 1 Hz frequency of following). Increase of death rate, reduction of behavioural activity of rats, morpho-functional infringements in a brain and a thyroid gland, digestive system (a liver and thin intestines), haematopoetic system, easing of immunity is revealed. The degree of adverse changes depend from E and duration of exposure.

With use of mathematical model of calculation of induced by pulse fields with various amplitude-time parameters current densities in models of rat and human body, it is shown, that the revealed adverse changes are marked at current density about 400 A/m² that is a threshold of this type electromagnetic pulses hazard effect.

GUARANTEEING OF OFFICE WORKER SAFETY – HYGIENIC AND CLINICO-IMMUNOLOGICAL ASPECTS

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Guaranteeing of worker safety in various branches of industry is based on development of effective monitoring system and assessment of degree of unfavorable occupational factor influence upon worker health. Office workers are a large group of workforce formed in recent years. They work in office buildings and use various office apparatuses such as computers, copying machines. Thus, working condition sanitation of office workers became a new medical problem.

Analysis of Russian and foreign literature, as well as results of our investigations gave evidence that office workers exposed to a complex of occupational factors: physical (electromagnetic field and static electricity, unfavorable microclimate, low lighting), chemical, biological. The degree and domination of influence of the factors may be various and depends on specific characters of work organization at workplaces. Psychological factor (nerve-emotional status, overcrowding of personnel, conflicts at work) plays a significant role in modern working conditions with high level of computerization of working process management.

The observations on health of workers exposed to video display terminals showed that they primary had strain of central nerve, visual and cardiovascular systems. Decreasing of adaptation abilities of organism has been observed even by short length of service. It leads to disorders of adaptation processes (decreasing of functional activity of antioxidant system, activation of free radical oxidation processes), inhibition of immune reactivity with formation of immunodeficiency status.

Status of immune system and adaptation processes should be studied to reveal early signs of unfavorable occupational factor influence upon office worker.

Clinical signs of immuno-pathological disorders were revealed in a half of examined workers, inflectional and allergic syndromes were revealed approximately in 1/3 of cases. By assessment of function of system and local immunity along with clinical signs of immunodeficiency and immuno-pathological disorders, the revealing of the disorders allows to fulfill preclinical diagnostics of a possible disease caused by a complex of unfavorable factors. It will contribute to prediction of diseases and fulfillment prophylactic measures.

IMMUNE AND BLOOD SYSTEM EFFECTS OF RADIO-ELECTRONIC INDUSTRY WORKERS AND CIVIL AIR- CRAFT RADAR OPERATORS MICROWAVE EXPOSURE

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With the purpose of evaluation of health effects of electromagnetic fields (EMF) of microwave range (MW) in a combination to concomitant factors (noise, a microclimate, intensity of work) occupational exposure it is carried out immune and blood system inspection of 131 persons (16 women and 154 men) verifiers of electronic devices and traffic controllers of radio equipment and 145 men – the staff serving systems of a radar-location and communication in civil aircraft. The morphological structure of blood, amount and ratio of the basic lymphocyte subpopulations, activity of energetic metabolism, lyzosomal enzymes and parameters of anti-oxidized protection in immune-competent and phagocytized blood cells are investigated; it is carried out the cytogenetic analysis of chromosomal aberrations.

Staff – testers of electronic devices were exposed to MW EMF with $10 \mu\text{W}/\text{sm}^2$ power density (PD) average values, power exposition (PE) for work shift – up to $70 \mu\text{W}/\text{sm}^2 \cdot \text{h}$; traffic controllers of radio equipment were exposed to interrupted MW (2–3 hours for shift), PD was reached to hundreds of $\mu\text{W}/\text{sm}^2$; civil aircraft radar system operators MW PE exposure was 30–100 $\mu\text{W}/\text{sm}^2 \cdot \text{h}$.

There were revealed: changes of parameters of peripheral blood as cytopenic reactions of leukocytes and erythrocytes and occurrence of erythrocytes with basophil granularity; changes of a cellular metabolism of leukocytes - increase of activity of acid phosphatase and energetic enzymes in lymphocytes and different directional changes of activity of alkaline phosphatase in phagocytized blood cells. Changes of the immune status with attributes quantitative - functional immune deficiency (reduction of lymphocytes number and shifts of of immune system regulatory subpopulations (T-helpers and T-suppressors) ratio. Are found out cytogenetic infringements as aneuploidia, polyploidia, increase of quantity of aberrations of chromosomal type (dicentric and double acentric fragments).

METHOD OF COMPLEX RECOVERY OF PERSON AS FACILITY OF OPTIMIZATION PSYCHOPHYSIOLOGIC STATUS IN PROFESSIONAL ACTIVITY OF MAN-OPERATOR

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National association "Health"

Number of factors, negatively influencing upon the functional condition and productivity professional person activity of operator profile highly great. Aside from the factor non-ionizing radiating, in their list enter in the same way monotonic, hypodynamic and others. Developed by us strategy (hereinafter - a Strategy) decides a problem of optimization of psychophysiological status of person to the account of protection from the influence of specified factors. Strategy presents itself a composition once-personal types of motor activity, which execution can be produced as right in a time of realization of professional activity parallel with her on the working place straight that very it is important, as well as during small breaks. At the development of strategy used principles and phenomena: normation physical load; non-stop activity; biological feedback and others. High adaptability of strategy allows it's effectively use any users.

Presented strategy is referred to the valeological class. It is directed not only on eliminating the negative consequences of action of different factors, as well as on the struggle with factors themselves, causing these effects.

Evaluation of influence of Strategy on the condition and person activity, conducted by means of different methods (frequency pulse, frequency breath, arterial pressure, integral evaluation psychophysiological status on strategies A.F.Konkova and A.F. Bobrov) give positive results.

Copyrights and priority to the Method are protected (Patent RF N2177335 from 27.12.2001, priority from 10.10.2000). Rights on commercial usage belong by National association "Health" (director V.M. Nazarov, contact tel. 906-4895)

EXPERT ASSESSMENT OF WOMEN-PC USERS' HEALTH STATUS

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These estimations of self-feeling and factors of risk for the health were obtained basing on the interrogation of 100 women-PC users at the age of 18–

50 years; the length of service was 2–25 years. The anamnestic questionnaire included the passport data, it also evaluated the labour conditions, conditions of the life mode, social-economic factors and the health status. The health status was assessed according to the presence and rate of symptoms characterizing the functional state of organism and also according to the frequency of diseases during the last two years. All indices were registered in points. The electromagnetic fields were measured at the working places. The results of the anamnestic study showed that the PC-users with the length of service more than 10 years complained of headache, worsening the memory, sleep disorders, troublesome sensations in the heart, lowering the appetite and digestion disorders, skin irritation, pains in the joints of upper extremities considerably more frequently than persons with more short length of service. With increasing the length of service with PC the growth of the chronic overstrain and vision discomfort is observed. From 60 up to 85% of respondents complained of the increased nervous-psychic load, the volume and intensity of the work, and also noise and unfavourable microclimatic parameters. The influence of the organization factors of the labour conditions on the health status was revealed. The increased morbidity rate in smokers and persons with the low income per one member of the family was marked.

HYGIENIC EVALUATION OF CIVIL AIRCRAFT AIRPORTS RADAR-LOCATION, RADIONAVIGATION AND COMMUNICA- TION MEANS STAFF WORKING CONDITIONS

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Hygienic researches of working conditions of the personnel which is carrying out operation and technical repair service of means of a radar-location, radionavigation and communication of the KYRUMOGH (Samara) and PULKOVO (Saint Petersburg) airports testify that their are exposed to complex factors of the occupational environment and labour process, the most important factors are electromagnetic fields (EMF) and noise.

It is shown, that electromagnetic environment in inspected objects is defined special multiple and specificity (technogenic EMF of broad band spectrum of frequencies of pulse and continuous generation with constantly varied intensity-time parameters, deficit of natural EMF in the shielded rooms). The detailed data of EMF values distribution at workplaces of the personnel in

technical rooms with radar-tracking and radio-navigation equipment, landing radio-beacon station, transmitting broadcast station etc. is established. In territory near antenna-feeder systems the detailed data is established too. Different types and power of sources, generation and radiation modes is taken into account. Power expositions values in dependence of exposure and a kind of carried out work of the personnel for a working day are calculated. Personnel exposure has complex discretely – interrupted character. In some cases an adequate hygienic evaluation may be difficult and may result in EMF influence underestimation in development of changes in a health state of the service personnel.

Daily equivalent sound levels on the majority of the workplaces exceeded hygienic normative values, especially in technical rooms.

Investigation results of a complex of the appreciated factors allow us to estimate working condition in most cases as harmful – category 3.2-3.4 according Hygienic Guide P-2.2.755-99.

CIVIL AIRCRAFT RADAR-TRACKING SYSTEM STAFF HEALTH STATE

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Health state of the specialists serving means of a radar, radionavigation and communication means, was studied at 2 airports (St.-Petersburg and Samara) by results of clinical and physiological inspection of 171 men (therapist and neuropathologist examination, cardio-vascular and nervous system physiological researches, blood, immune and cytochemical research) and social – hygienic research (basic group 250 men, group of comparison – 312 men).

The statistically significant increase of biological age in comparison with calendar (for 5.3 years), more high frequencies of cardio-vascular system pathology, the tendency to vegetative as well as vascular disfunction increase were revealed.

There were revealed quantitative – functional changes of blood cells (decrease of hemoglobin and erythrocytes amount, as well as thrombocytes quantity and cytopenic reactions), changes of leukocytes cell metabolism (increase of acid phosphatase and myeloperoxidase activity, and different directed changes of alkaline phosphatase activity), lymphocytes absolute quan-

tity decrease, changes of immune system regulatory subpopulations absolute number ratio (T-helpers and T-suppressors) and B-cells and T-zero lymphocytes quantitative structure populations. These results testify to infringement of the not specific factors of protection and immune system reaction ability and quantitative – functional immune deficiency formation.

The social – hygienic research executed by a method of cross research, has revealed in these group of specialists high levels of prevalence of cardiovascular system diseases, hypertension and ischemia illness of heart including, and formation its in younger age in comparison with the airmanagers, their work high intensity is proved in numerous researches.

ESTIMATION OF HEALTH CONDITION OF EMPLOYEES WORKING IN CONDITIONS OF ELECTROMAGNETIC RADIATION.

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It has been suggested presence of non-stages, and clinical variants of currency of radio-wave decrease for several last years.

This paper aims at an estimation of health condition variations of employees working in conditions of electromagnetic radiation on Saratov RTV station.

It was examined 42 persons (9 persons with experience of work till 5 years, 11 - with experience of work from 5 till 10 years and 22 - with experience more than 10 years) by utilizing of an outpatient cards. The changings of blood are prevail, especially of erythrocytal and thrombocytal appendix. The changings of nervous system as vegetative-vascular dystonia and cardiovascular system as a deviations on electrocardiograms, hypertensive disease and atherosclerosis have been diagnosed. All these conditions prevail among the persons with the huge experience of work.

The profound examination of 11 workers with experience of work more than 10 years has revealed infringement of heart conducting function and the haemotogenic shifts on the part of all appendixes. Deviations in lipid exchange and haemostasis system was determined in 5 cases.

Thus, in a clinical picture of employees working with electromagnetic radiation prevail haemotogenic syndrome and infringement syndrome of the conducting function of heart. Probably, the combination of these syndromes is a variant of microwave decrease currency.

CASES OF HYPERSENSITIVITY DUE TO ELECTROMAGNETIC FIELDS SOURCES. ISSUE MANAGEMENT

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The phenomenon “environmental diseases”, also named “electromagnetic hypersensitivity” (EHS) is quite frequently mentioned and discussed at present. Although the specialists consider the issue of EHS existence as unbiased, the World Health Organization (WHO), based on the European Commission report (Bergqvist and Vogel, 1977), International EMF Conference and the Workshop on non-specific health symptoms (COST 244bis, 1998), outlines particularly these cases, suggesting that 10% of the reported EHS cases are severe.

In Bulgaria data are collected, concerning individuals declaring EHS, through passive selection, i.e. the individuals themselves have addressed the specialists. The individuals complain of different health problems similar to those described by the WHO. The cause they suggest for their impaired health status are different EMF sources – power distribution facilities, VDUs, mobile phones and their base stations, domestic and heating appliances, etc.

The complexity of this issue requires a strategy that should necessarily comprise effective Public Relations (PR). Conforming to the WHO concept on the International EMF Project, we submit a Program for Issue Management for individuals with EHS, with the following major steps:

- Registration and examination of individuals with EHS complaints;
- Classification of the priorities;
- Choice of strategies;
- Realization of action and communication programs;
- Assessment of the effectiveness of the process.

On the basis of existing case studies in Bulgaria, this presentation will outline an action program for risk management for individuals who claim to be hypersensitive to EMF. The initial information for such persons will be collected actively and processed case by case. The strategy for further actions will be particularized depending on the general results.

HYGIENE OF A TRANSACTIONS AND BIOLOGICAL EFFECT of electrical FIELDS by FREQUENCY 10-60 KHZ

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Despite of the rather vast literature on biological effect EMF (electromagnetic fields) of radio-frequency range the problems tangent hygiene of a transactions and influencing EF (electrical field) by frequency 10-60 kHz, created by the low frequency equipment including a computer with VDT (video display terminal), in the domestic and foreign literature are lighted unsufficiently. This circumstance, and also absence of the hygienic standards for EF of the indicated frequency band have caused of realization of researches on analysis of working conditions of faces maintaining the equipment, generating in a working area EF by frequency 10-60 kHz, finding - out of nature of biological effect of the given factor on an organism animal with the purpose of the substantiation of marginal levels.

The executed researches have shown, that by activity of the indicated equipment the attendants are exposed to a complex of the unfavorable factors of manufacturing medium including EMF.

In laboratory conditions the experimental researches on analysis of biological effect EF by frequency 10 and 60 kHz by tension 10, 4, 1 and 0,1 kB/m with a daily exposition 1,3 and 6 hours are conducted. Thus the method of testings describing a functional condition nervous, cardiovascular and other systems, and also generative function of an organism were used. The data of experimental researches have allowed to conclude, that EF by intensity 10 and 4 kB/m exerted influence on a condition of cardiovascular and central nervous systems, physical development animal, invoking in their organism authentic changes dependent on frequency, field intensity and duration of its effect, also have gonadotrophic operating, which one is more expressed to the end of effect and aftereffect. The operating by tension of 1 and 0,1 kB/m did not invoke noticeable changes on the part of investigated systems and gene-sial function. Therefore tensions EF 10 and 4 kB/m can consider (count) as the operational values, and 1 and 0,1 kB/m - close to a threshold of physiological operating.

6. DOSIMETRY AND EVALUATION OF ABSORBED DOSES

STRUCTURAL REORGANIZATION OF WATER AS INDICATOR OF ELECTROMAGNETIC INFLUNCES

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The spectrophotometric investigation of water samples (distilled water, sweet water, spring water) in the ultra-violet waves range 200 nm to 340 nm. The distilled deep demineralized with special active filter system water was used as a control.

The measurement of water samples optical density has revealed the exponential dependance on wave length with highest values in short-wave ultra-violet area. The further research was carried out at 200 nm.

The water samples investigated by the same room temperature earlier subjected to boiling or freezing, as well as missed through magnetic funnel, differ essentially on the optical density value. This suggest that the tested spectrophotometry method allons to register the change of samples optical absorption under influences of external influences. And these changes are caused, most likely, by water molecules structural reorganization.

The definition of water optical density within one day and in the period from Novemder till February have shown that the samples of optical absorption changes in

limits of $\pm 110\%$ and this is most likely connected with gelio-spaced influences on water.

Using the water samples spectrophotometry placed in front of computer on a distance of 60 sm, it was established that the optical density deereased by exposition from 1 to 6 hours depending on duration of influence in the limits 35-60 units of density.

The radiation influence of ultralow intensity, generated using the copper mono-cristals (the V.A. Murovtev quantum generator of superweak filds) by 10 minutes exposition have changed the water samples optical density on 10–20 units.

The data obtained are discussed in connection with possibility of spectrophotometric indication of electromagnetic radiation influences, even ultralow intensity. The efficiency of influences are revield in the water molecules structural re-organization. It can be suggested, that electromagnetic

radiations even ultralow on intensity can render through the water modifying influences on metabolic processes in the organism, changing its course in the destruction, and homeostasis restoration, i.e. can be the “lever”, regulating the process of metabolism and energy changes.

EMF STANDARDS AND METERS DEVELOPED AT WROCLAW UNIVERSITY OF TECHNOLOGY AND USED IN EMF MEASUREMENTS IN POLAND

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Theoretical, experimental and application research relating to electromagnetic field (EMF) metrology has been conducted at the Institute of Telecommunications and Acoustics (ITA) of Wrocław University of Technology for over 30 years now. The experience gained from it has been used to design EMF probes and meters with higher measuring accuracy and capacity to keep up with the market demand.

It has become necessary to supply the institutions involved in the drafting of protection standards with meters enabling them to accurately determine the existing hazards posed by EMF sources and to develop exposure systems for the investigations. To ensure correctness and comparability of measurement results, the institutions must be supplied with identical or similar measuring equipment. Unfortunately, the equipment which they have is far from meeting this requirement. The equipment is often not up to the standards in force or the ones being drafted on the basis of the measurements and it does not comply with the relevant national and international regulations.

As a result of the research, the frequency ranges covered by the regulations have been extended and the approach to individual frequencies (e.g. the power line frequency of 50 or 60 Hz) has been changed. In the binding standards and the ones being drafted, relating to the Highest Permissible Intensities (HPI) for the two components of both the electric and magnetic field, the measuring range of the magnetic component has been extended from 10 MHz to as much as 3 GHz.

The EMF Standards and Measurements Lab focuses on the primary and secondary EMF standards used in international comparisons made by NIST (USA) which are then used in EMF research and measurements and to calibrate EMF meters of the MEH type developed by ITA. The meters are widely used in Poland to determine boundaries of safety zones in companies

and in general public protection against harmful effects of EM radiation. The measuring equipment's frequency range is from a few Hz to 40 GHz and primary EMF standards stations cover a frequency range of 0–50 GHz.

SAR - VALUES CALCULATION FOR THREE DIFFERENT EMF-IRRADIATION CASES

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Every time when the scientist tries to calculate SAR values by concrete experimental design a problem arises. This is much more important when the quality of the protocol of a study should be assessed. Calculations are needed also, when we are trying to compare different experiments with uncertain description of dosimetry.

Aim of report is to contrast conditions & arrangement of object irradiation and corresponding SAR-values. Referred cases are the following occasions: radiobroadcasting and TV stations maintaining personnel in EMF, an exposure of a biological preparations in Petri-dishes (homogenate, lambeau, and fascia) in a published experimental situation, and a quasiwaveguide thermometry of experimental study carried out in Romania. All three cases of direct measurement estimation state uniform trends of exceeding the 4 W/kg. Computational schemata proved identity what is ascertained as far as there is a formula's connecting wave impedance with a functional of irradiated surface.

This study gives an opportunity to evaluate studies with good design but fails in dosimetry.

FEATURES OF DOSIMETRY OF ELECTRICAL FIELDS AT UHF-THERAPY (27.12 MHZ)

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The application of mathematical methods of definition of the absorbed energy of electromagnetic fields by animals and man has allowed to expand considerably submissions about observed biological effects. Nevertheless, it is necessary to recognize, that in the most answering practical purposes, in particular at the application of ultrahigh-frequency (UHF) electrical fields in therapy, is an instrumental method of definition of a specific absorbed dose.

The objective, quantitative dosimetry as against subjective feeling of warm by the patient, allows to optimize the process of treatment, to differentiate the value of a dose depending the on selected policy of therapy, and also to reduce up to a minimum spurious or “not physiotherapeutic” effects of irradiation, both the patient, and medical staff. For creating the means of measurement the absorbed dose of UHF electrical fields by tissues of a body of the patient will precede the analysis of a system: condenser laminas of a therapeutic contour – air interspace – body of the patient from stands of electrical properties (conductivity and capacitance). The measurements made by a method of a transformer resonance bridge on frequency 27.12 MHz, have shown non-linearity in absorption of an electromagnetic energy by an object unbound by air gap from condenser laminas of a contour, and the value of maximum rating did not depend on intensity of an electrical field in range of values, used in experiments. The greater influence on the value of an absorbed dose of energy of an UHF electrical field rendered, as it is not paradoxical, the change decreasing or increasing of air gap between condenser laminas and body of the patient, and the non-linear nature was watched in this case. It is possible to suppose, that the changing of spacing interval between the condenser laminas and body of the patient influences the nature and the value of absorption of energy of an UHF electrical field of frequency 27.12 MHz on the patient by a decisive mode.

RADIO FREQUENCY RADIATION DOSIMETRY IN MAN AND ANIMAL COMPUTER MODELS

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Accurate dosimetry is a critical part of any scientific effort to assess the effects of electromagnetic fields (EMF) on biological systems. In addition, conducting high quality dosimetry and reporting detailed descriptions of the dosimetry are essential to permit precise replications of experiments by independent laboratories. Dosimetry includes the measurement of the incident and internal fields. However, these fields can be quite different, depending upon

the characteristics of the object, including: size and shape, electrical properties, orientation with respect to the incident field, and the frequency of the incident field. Therefore, the development of mathematical dosimetry modeling techniques and powerful computer hardware has resulted in computer modeling as a principal tool in assessing the biological effects of EMF exposure. The man dosimetry model developed by the U.S. Air Force was used in the present study to determine the resonance frequencies of the whole body and internal organs as a function of object orientation with respect to the incident field. Consistent with the Radio Frequency Radiation Dosimetry Handbook (Durney et al., 1986), the resonance frequency for the whole body standing man is approximately 70 MHz when exposed in the EHK orientation. When this incident field is propagated in the ventral-to-dorsal direction, the resonance frequency for the brain, oral cavity, and testicles is approximately 800 MHz. When the incident field is propagated in the dorsal-to-ventral direction, the resonance frequency for the cerebellum and brain stem is approximately 240 MHz. Since validation of these human models is difficult or impossible with living human subjects, we have also developed animal dosimetry models that we compare to empirical animal data. Good agreement between the theoretical and empirical animal data provide support for the validity of the specific absorption rate values predicted in the man model. Validation of the computer models with empirical results and the subsequent refining of the models are essential in order to earn the confidence and credibility needed to use these models to establish or revise exposure standards. The views, opinions, and/or findings contained in this report are those of the authors and should not be construed as official policy of the Department of the Navy or Air Force, Department of Defense, or U.S. Government. Approved for public release, distribution unlimited.

**CALCULATION MODEL TO ESTIMATE THE INDUCED CURRENT
DENSITY IN BIOOBJECTS FOR HYGIENIC
STANDARDIZATION OF NANOSECOND
ELECTROMAGNETIC PULSE IMPACT**

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At present wide-range EMP of nanosecond duration are used for testing technical systems on EMP safety. The results of theoretical, clinical and

experimental investigations testify to an unfavourable influence of permanent impact of EM fields source pulses on personnel health. The purpose of the presented paper is to choose and substantiate the considered impact parameters for hygienic standardization. Calculation studies on the estimation of various EMP impact parameters on experimental animals (rats) have been carried out. The calculations were conducted on the physical-mathematical model of a rat using our own program product (<http://www.pool-7.ru/~zelenin/>) representing the solution of Maxwell differential equation system by finite-difference time-domain (FDTD) method. The calculations were corroborated experimentally by measuring currents induced in a rat. The experiment on rats applying the present pulse amplitude-time characteristics has been planned on the basis of the calculated estimates. Experimental data analysis reflected the best correlation of clinical and functional animal state indices with the induced current density (ICD) parameter in bioobject body. ICD levels being the cause of the unfavorable biological effects have been substantiated. To extrapolate data obtained on rats we have conducted calculation to estimate ICD levels in humans by using the above-mentioned program-mathematical technique. It is reasonable to apply the developed calculation model for estimation of various amplitude-time parameters of EMP impact.

FUNCTIONAL CAPABILITIES OF THE “GOLDEN COCKEREL”, A SET OF INSTRUMENTS (RIMP AND RIEP) FOR MEASURING THE INTENSITY OF MAGNETIC AND ELECTRICAL FIELDS

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The multilevel RIMP-50/2.4 and RIEP-50/10 were designed for the detection of electromagnetic emissions (EMEs) from various neural sources and the measurement of these EMEs in the environment, the workplace and the home.

RIMP-50/2.4

- Measures the intensity of magnetic fields in the 40 Hz to 10 kHz range and provides output via a LED display, with 10 levels ranging from 0.12 to 2.4 A/m. The trend in amplitude-frequency response at each level is harmonised with the maximum admissible level curve (San. Pin 2.2.2 542–96).

- Indicates the existence of EMEs of modulated and impulse fields in the SW, VHF and microwave ranges.

- Provides an easy method for evaluating the angle of inclination of the magnetic field.

- Affords an indication of the non-compensated current running through a power cable or earth bus.

RIEP-50/10

- Measures the intensity of electrical fields in the 40 Hz to 10 kHz range and provides output via a 12-scale indicator from 100 to 500 (800) V/m.

- Reveals the polarity of static electricity on the surface of a material and the field strength.

- Indicates the existence of EMEs of modulated and impulse fields in the SW, VHF and microwave ranges.

- Affords an indication of the resistance of an electrical chain up to 5.50 and 100 M Ω and the existence of voltages up to 250V in AC and DC chains via the contact method.

The accuracy of the RIMP-50/2.4 and RIEP-50/10 has been attested by comparison with readings given by the IMP-5, IEP-5 and IEZ-P. At the same time, the “Golden Cockerel” costs 25–35 times less than other well-known instruments on the market. The devices are certified by the State Inspectorate, approved by the national sanitary inspector and recommended by the Moscow Education Committee for use in the classroom. Each unit weighs 0.07 kg (with battery). It can be used in a range of temperatures from -5 to 35 (40) degree celsius. The RIMP is powered by one 1.5 AAA battery and the RIEP by two 1.5V LR44 batteries.

DENSITY OF A STREAM OF ENERGY OR SAR?

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During a long time in Russia is discussed a question on criterion of an estimation of electromagnetic safety of radio telephone terminals. Thus there is a question: “What to accept for criterion of an estimation of electromagnetic safety – **Density of a Stream of Energy** or SAR?” In the international practice of hygienic normalization this question is unequivocally solved for the benefit of SAR. We shall formulate the basic requirements to criterion of an estimation of electromagnetic safety of radio telephone terminals.

First, the criterion should reflect *essence of the physical processes* occurring at interaction of electromagnetic fields and a head of the person. From the theory of antennas it is well known, that parameters and characteristics of radiation of antennas change in a large extent at an arrangement of radiating elements near to the materials, which having conductivity. Normalization **Density of a Stream of Energy** for a lonely radio telephone tube does not take into account real physical processes, which essence in interaction of biological tissues with radiating elements, as a result of which tissues exists as elements of the antenna.

Second, the parameter should be *verified and controllable*. In ranges of work of mobil systems of communication, **Density of a Stream of Energy** in a near zone basically may not be measured, and transition in a distant zone in a field of a plane wave, reduces normalization to comparison radio telephone terminals on radiated powers and to gains of antennas.

Thirdly, **Density of a Stream of Energy** it is the characteristic of a field in any point, and does not represent interest – the integrated estimation of electromagnetic safety is necessary.

Fourthly, it is necessary to take into account, that in Russia radio telephone tubes of foreign manufacturers which will be certificated on SAR are used. There is a question on *harmonization of norms and standards of the various countries* – to compare **Density of a Stream of Energy** and SAR it is not possible, because of their various physical essence.

It is necessary to finish polemic and, basing on serious foreign researches to proceed in Russia on SAR as for users in Russia this parameter becomes more and more habitual, thanking Internet.

SOME QUESTIONS OF EXTRAPOLATION EMF BIOEFFECTS

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On the basis of the analysis of data literary and own research the questions and principles of carry of bioeffects EMF from animal to a man are considered. The meanings of extrapolation factors are submitted depending on conditions of influence EMF and biological parameters of animals.

For low-frequency area EMF it is offered to take into account the size of lonely electrical capacity of bioobject at extrapolation.

On the basis of research of response reaction CNS on weak high-frequency EM radiation with not thermal intensity is shown, that for reactions of the identical biological importance which is not deviating from limits of norm, in identical conditions of influence, extrapolation factor from an animal to a man is equal 1:1.

PERFORMANCE OF FDTD: ORGAN RESONANCE AND WHOLE VS. PARTIAL BODY MODELS

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Accurate empirical measurements of electromagnetic-field (EMF) exposures are difficult to perform. EMF exposures typically are measured in specific absorption rate (SAR). Localized SAR measurements can be made using temperature or E-field probes. Whole body SAR can be measured using calorimeters. Only with the use of realistic anatomical models and methods such as the finite difference time domain (FDTD) has the ability to estimate both the whole body, as well as a very large number of localized SARs been possible. Empirical research is aided by this tool even at the qualitative level by suggesting where localized SAR measurements should be made. Currently, virtually all exposures in our laboratory whether human, animal, or phantom are preceded by an FDTD analysis. Gradually, it has become apparent that not only do whole body SARs exhibit frequency-dependent variations, or resonances; but so do individual organs and body sections (e.g., limbs and head). But, no tool is perfect, and we continually explore for the limits and for possible areas of improvement. As part of this effort, an examination of eye resonance in the isolated head was compared to eye resonance in the whole body simulations at the same frequencies and orientation. Differences here are of some importance as researchers may use partial body simulations to limit the computing resources a simulation would require. Different results with whole versus partial body simulations would tend to limit the value of partial body models. The whole body resonance phenomenon is dependent on the overall size of the body. The energy contributing to that phenomenon is distributed throughout the body. Our results show that by omitting sections of the body the overall size is changed which also changes the resonance characteristics. And that these changes are manifest in changes in the local SAR as well. This suggests that partial body models must be employed with care.

7. PROBLEMS OF EMF SAFETY

THEORETICAL AND EXPERIMENTAL ASPECTS OF PEOPLE PROTECTION FROM ELECTROMAGNETIC FIELDS. THE ISPESL ACTIVITY

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A continuously growing attention towards electromagnetic pollution has characterized the last years in Italy. Both the possibility of effects on human health and the necessity of modern society to increase the communication systems have been the two more important driving forces. The former concerns both the acute effects, typically considered by the limits suggested by ICNIRP, and the so called long terms effects. On the other hand, the communication development, especially the mobile telephone, requires much more transmission systems. To take into account both the limited scientific knowledge and the people concern on long term effects due to electromagnetic fields, quite recently in Italy a dedicated law (Decreto Interministeriale (DI) no. 381/98) has been given off. The objective has been achieved by the introduction in the law of two different exposure limits. The highest of them to avoid the acute effects and the lowest to try to prevent the long term effects.

The ISPESL (Istituto Superiore per la Prevenzione e la Sicurezza del Lavoro) is a technical Institute of the Italian Health Ministry. Among its activities the Institute also gives its consultancy and contribute to the study of electromagnetic pollution. During the last few years studies and measurements have been performed by ISPESL throughout Italy. The respect of the limits imposed by the DI no. 381/98 has been verified and, when necessary, technical suggestions have been provided in order to reduce the electromagnetic emissions. The present paper describes the experience made both with experimental and theoretical work. In particular data, referred to electromagnetic fields, acquired over two areas of Rome are reported and discussed. References are made to the arguments actually in progress on the effects of electromagnetic fields on human health in one of the two chosen areas.

MAGNETIC FIELDS IN ELECTRICAL TRANSPORT

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Development of transport networks on urbanized areas implies a considerable increase of using more communication and informational technologies (means of telematics). They crucially stimulate the increase in efficiency and economy of the transport infrastructure at the expense of transport traffic minimization. On the other hand, the supply of motor vehicles with means of electrical and electronic comfort is ever increasing. The means of transport with an electric driving motor turn out to be more preferable to fulfill the norms of toxic standards. As a result the transport vehicles and road infrastructure become a serious source of the electromagnetic pollution of the environment. This factor taken together with existing psychological stresses exerted upon a driver moving in dense traffic streams produces a negative influence on human health and increases a number of road accidents. The magnetic field in electric transport undergoes rapid changes in the process of motion as it was shown by the authors [1]. Our measurements show that the magnitude of magnetic induction in a moving trolleybus varies within 20–90 mT . Some abrupt variations of the magnetic induction have been recorded in our experiments in the driver's cabin, in passenger area over the driving electric motor and in the vicinity of the cabin. The motion with frequently changing acceleration and deceleration produces the significant pick-a-pick amplitude of B as it was observed in the experiment. The magnetic field observed in the passenger area is less almost twice as the geomagnetic field. This decrease depends upon the state of the atmosphere: the more humidity, the more the decrease.

One of possible ways to smooth the abrupt changes of the magnetic induction is making the passive closed conductive circuits or the active ones in connection with ferro-probe instruments to measure the magnetic fields.

[1] Y.A. Kopytenko, G. Villaresi, N.G. Ptitsyna, E.A. Kopytenko, V.S. Ismagilov, D.B. Zaitsev, P.M. Voronov, M.I. Tyasto, N. Iucci, D. Pfluger. EMF safety conference, Moscow Sep 1999.

FIBROUS RADIOABSORBING MATERIALS BASED ON POLYMER COMPOSITES

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Melt-blowing method has been developed to produce fibrous radioabsorbing materials (RAM) based on polymer composites. The method comprises the extrusion of the granulated blend of a thermoplastic polymer and dispersed functional filler, which provides high electromagnetic losses at interaction with radio waves, through a spinneret. Then fibers are extended by a gas flow, transported and deposited onto the forming substrate as a non-woven fibrous mass. In particular, the flexible fibrous sheets based on compositions containing thermoplastics and powdered magneto-soft ferrite can be used as parts of radar protection clothes. The combined RAM of "sandwich" type consist of alternating layers of the fibrous composite and the carbonic fabric of different structure and electric conductivity. They are intended for electromagnetic protection of industrial buildings and constructions as sealing and facing materials.

Formulational, dimensional and structural characteristics of RAM have been optimized by criterion of highly radio absorption within a wide radio-frequency range. Non-woven composite sheets are characterized by considerable electromagnetic losses being of small thickness and mass. Such materials answer radio-technical, physico-mechanical and ecological requirements, posses sound-absorbing and heat-insulating properties. Their application will provide increasing electromagnetic safety of engineering objects and servicing personnel.

IN OUR PAPER THE FULL CLASSIFICATION OF SYSTEMS IN WHICH THE STRUCTURAL-DISSIPATIVE RESONANCE MAY OCCUR IS GIVEN AND THE BASIC PROPERTIES OF IT ARE PRESENTED

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Investigation of Non-Ionized Electromagnetic Fields of Azerbaijan Republic'S Electric Power Systems. Protection Measures.

One of the main aspects of energetics' ecological problems is the environmental contamination by the means of non-ionized electromagnetic fields (NIEF), radiated by power industry's plants and equipment especially of high and super- high voltage (HV, SHV) ones, which exert a considerable detrimental effect on physical and biological objects and human's health.

In connection with that and as a result of up-to-date electrification and electronization rapid development, the problems of electromagnetic compatibility and electromagnetic safety in technical and biological fields gained a great keenness. It is especially urgent for the staff of electric power systems (EPS) and electric power units who, because of their professional activities, are exposed to long-term radiation of high intensity NIEF and for the inhabitants, resided near the HV and SHV objects.

The full-scale tests of NIEF in the most part of 500, 330, 220, 110 kV substations of Azerbaijan EPS were carried out for the purpose to determine the real NIEF's characteristics of HV and SHV objects and to develop the protection measures of health care and human safety. The influence of season factors, redesigns and equipment modernization on NIEF's characteristics, effectiveness of biological protection and so on was also determined.

The methods of investigations are also considered in the paper, the information about characteristics of used measuring facilities are given, the results of obtained data's processing and analysing are shown, and the versions of "Electric fields' intensity maps" drawn up on their ground are adduced.

For the substations with outdoor and indoor switch – gears (OSG, ISG) of different intensity levels the obtained values of electric field intensity (E) within the operating zones, often visited by personnel, are: for OSG of 500 kV – $E \leq 18$ kV/m, 330kV – $E \leq 16$ kV/m, for OSG, ISG of 220 kV – $E \leq 14$ kV/m, for OSG, ISG of 110 kV – $E \leq 10$ kV/m. Without the substations foundaries at the distance of up to 1km under the high voltage lines E is approximately equal to 1 kV/m.

According to republica is standarts and the ones of World Public Health Care Organization the mantioned E values outnumber significantly the long-term permissible sanitary norms. These data indicate the unfavourable condition of electromagnetic protection and that precaution arrangements must be taken. The study, carried out in the different year periods, indicated that in Azerbaijan environmental conditions the season factors influenced insignificantly on E values. There was revealed the dependence of E on structure and type of high voltage equipment.

It was recommended to use the biological protection measures in the zones with E high values, the duration of men being at these zones must be strictly limited with using the electric field quantimeters (EFQ), designed in

Azerbaijan Research Institute of Energetics and Energy Design. The results of investigation are used for complex certification of working places according to the labour protection norms and for forecasting of behaviour of high voltage equipment electrical insulation, for design correction.

EXTREMELY HIGH VOLTAGE OVERHEAD TRANSMISSION LINE MAGNETIC FIELD SHIELDING BY MEANS OF DIRECTED CONTOUR SCREEN

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Extremely high voltage (EHV) overhead transmission line (TL) magnetic fields (MF) are brightly expressed elliptic. Such line MF shielding on amounting of frame of the Descartes components has low efficacy. The di-

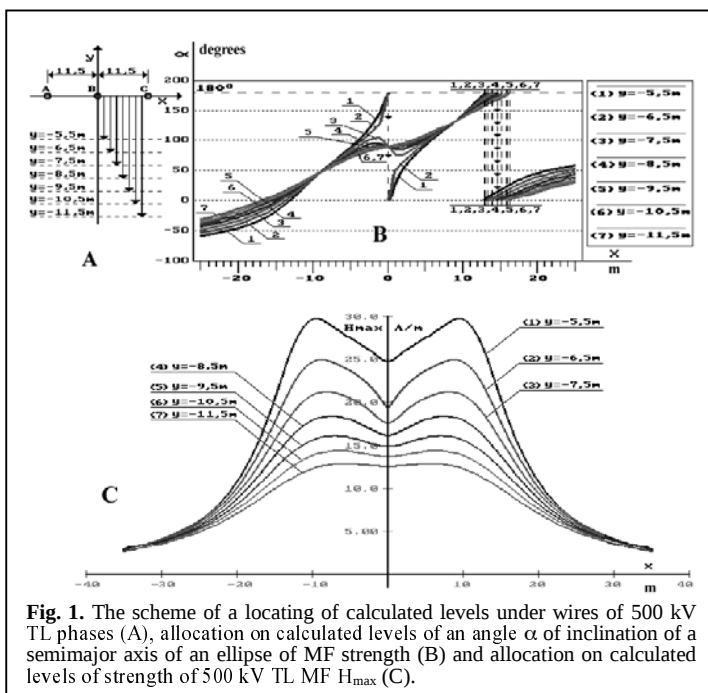


Fig. 1. The scheme of a locating of calculated levels under wires of 500 kV TL phases (A), allocation on calculated levels of an angle α of inclination of a semimajor axis of an ellipse of MF strength (B) and allocation on calculated levels of strength of 500 kV TL MF H_{max} (C).

rectional contour screens (DCS) allow to realize considerable lowering of MF in all ranges under EHV TLs. In figure 1 the allocation of angles (α) of incli-

nation of a semimajor axis of an ellipse to an axes OX is shown and the MF strengths till a semimajor axis of an ellipse $H_{\max}$ at different calculated levels under wires of 500 kV TL. At $X = 9 \text{ m}$ α are equal for all levels and in the same zones the maximums of $H_{\max}$ are. DCS place such by a mode, that in these zones the MF strengths, framed by them, were the same α , as TL MF α , and phase angles were shifted on 180° .

The application of two DCS for 500 kV TL allows to lower of $H_{\max}$ under TL on 20–25% in dependence on a type of the directional contour screen.

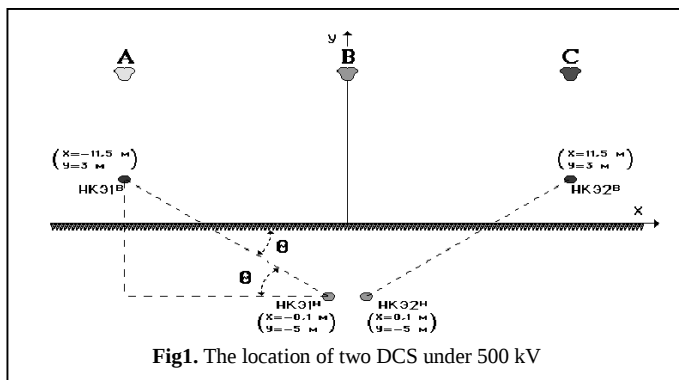
DIRECTED CONTOUR SCREEN TYPES FOR EXTREMELY HIGH VOLTAGE OVERHEAD TRANSMISSION LINE MAGNETIC FIELD SHIELDING

Dikoi V.P.¹, Korobkov N.M.², Tokarski A.Yu.²

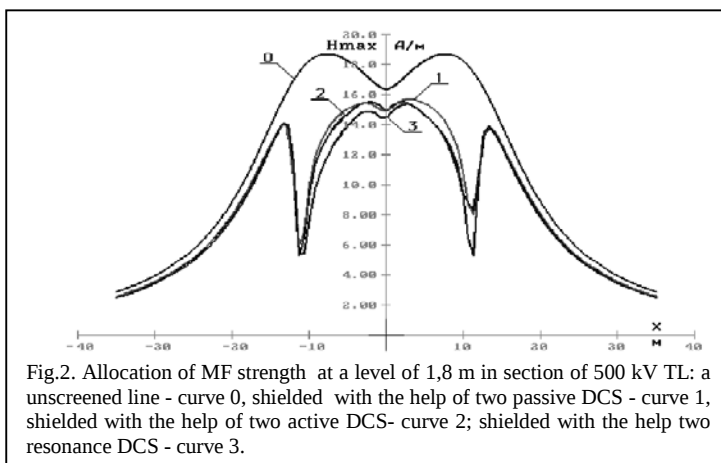
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For compensation of EHV overhead transmission lines (TL) magnetic fields (MF) the application of directional contour screens (DCS) is effective. In figure 1 the locating of two DCS (DCS1 and DCS2) under 500 kV TL of a conventional design is shown.



There were three type of DCS: passive, consisting from closed contours, in which MF of a line induces the compensation currents; active, in which the compensation currents are adjusted in module and phase angle by means of including in contour circuit the screens that correct electromotive force; resonance, in which circuit the capacitive reactances diminishing reactive parts of resistances of screen contours are included.



In figure 2 the allocation of MF strength at a level of 1.8 m in section of 500 kV TL is shown: a unscreened line – curve 0, shielded with the help of two passive DCS – curve 1, shielded with the help of two active DCS – curve 2 and shielded with the help two resonance DCS – curve 3.

50 HZ MAGNETIC FIELDS FOR NON-PROFESSIONAL EXPOSURE

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Sufficient increase of average background intensity of 50 Hz power supply frequency magnetic field (MF), as the new potentially dangerous environment factor in condition of non-professional exposure at workplaces and home is the subject of hygienist's attention.

At the period of 1998 to 2001 the specialists of Center for electromagnetic safety have controlled the electromagnetic field generating by industrial and civil objects, the main 50 Hz magnetic fields sources in Moscow. Data analysis allow to point out the next main sources of power supply frequency MF: cable lines (47.4% from the total sources number), distribution power systems (22.8%), building metal constructions and pipelines (15.6%), transformer substations (8.4%), high voltage power lines (3.5%), uninterrupted power sources (1.3%) and others (<1%). Power supply

frequency magnetic field levels less than 0.2 μT were discovered in 14.3% from the total number of the inspected rooms, 0.2–0.4 μT in 43.8% of rooms, 0.4–1.0 μT were found in 26.9%, 1.0–2.0 μT – 11.5% and in 3.5% were registered magnetic fields at the levels more than 2.0 μT .

In the adopted as a temporary sanitary and epidemiological norms and regulations (SanPiN) no. 2.12.1002–00 “Sanitary and epidemiological requirements to the dwelling buildings and rooms” (July 1, 2001) magnetic flux density’s level must not be more than 10 μT . In our opinion, such permissible level is not scientifically justified and according to modern point of view is strongly overstated. National organizations of several countries (Sweden, USA) have recommended the MF “safety” intensity at the level of 0.2 μT . It was set as threshold accounted from the correlation between MF intensity and leukemia cases caused by chronicle exposure. In the World Health Organization Fact sheet № 263 “Electromagnetic fields and public health. Extremely low frequency fields and cancer” (October, 2001), where the modern scientific knowledge are generalized there is the conclusion, that power supply frequency MF with magnetic flux density more than 0.3–0.4 μT are possibly carcinogenic to humans in condition of chronicle exposure.

According to the measurements made by the Center for electromagnetic safety from 1998 around 42 % of monitored rooms have had the power supply frequency MF level above 0.4 μT .

The most urgent problem in such situation is discovering of 50 Hz MF sources and realization of the effective protection measures in condition of irregularly electromagnetic situation instrumental and human health control.

Protection measures range is quite restricted. Protection by time is impossible to be used in condition of non-professional exposure. Protection by distance is hardly realized, because of the most 50Hz MF sources located at already working objects and it is unrational to change whole engineering infrastructure. Therefore, the most effective problem’s solution is reducing of 50 Hz MF intensity. Technically it could be realized in this way: magnetic field shielding; magnetic field active compensation system; reducing of currents, generating 50 Hz magnetic field.

One of the current reducing methods is suggested. This method provide the power supply system diagnostics and bringing it in correspondence with the national standards. Four-year experience have showed that the developed method allow to reduce 50 Hz magnetic fields levels with minimal expenses in 90% cases of monitored buildings in Moscow.

ANALYSIS OF PERENNIAL EMF MEASUREMENT DATA BASE AT PERSONNEL COMPUTERS WORKPLACES IN MOSCOW

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At the beginning of 2002 in Russia were accounted above 11 millions of professional personnel computers (PC) users and their number is constantly increasing. So the problem of biologically active physical factors control (including electromagnetic fields) at PC users workplaces became the urgent one.

In the sanitary and epidemiological norms and regulations (SanPiN) no. 2.2.2.542–96 “Hygienic requirements to video display units, personnel computers and work organization with them” the common requirements to the maximum permissible EMF intensity levels at PC users workplaces haven’t exited. It is considered that the main EMF sources at workplaces is a VDU. However, according to the practice, sufficient and very often determining part in PC users workplaces electromagnetic situation contributes the external 50 Hz power supply frequency electromagnetic field. As a rule the sources of increased levels of 50 Hz EMF electric component are ungrounded workplaces equipment. The increased levels of 50 Hz EMF magnetic component usually generate by unbalanced and/or leakage currents, for example on building metal constructions and pipelines, distribution power systems, uninterrupted power sources, set near the PC user workplace.

At the period of 1994–2002 the specialists of Center for electromagnetic safety have monitored EMF at 948 PC users workplaces, belonged to different firms and offices in Moscow. It was discovered that only in 37% of researched workplaces the electromagnetic situation have met the SanPiN 2.2.2.542–96. In 27% of workplaces the electromagnetic situation haven’t met completely to the requirements for 5–2000 Hz frequency range electric field, where 44% of cases have been caused by external EMF sources. 3% of workplaces haven’t met to the 2–400 kHz frequency electric fields requirements. In 29% of workplaces the electromagnetic situation haven’t met to the EMF magnetic component requirements for 5–2000 Hz range, where 84% of workplaces the increased magnetic flux density caused by external sources, located near the workplaces. 5% of workplaces haven’t met the magnetic fields flux density requirements for 2–400 kHz range. 19% of workplaces haven’t met the standard for equivalent electrostatic potential level.

The data analysis shows, that modern computer devices under condition of correct connection to power supply system cease to be the dominate EMF source at workplaces. In the most cases the electromagnetic situation is de-

terminated by external sources. However, until now the numeric violations of workplaces arranging and equipping are meeting. Incorrect workplaces organization together with the EMF increased levels have a bad effect on PC users health, cause dysfunction of organism's activity or development of serious pathologies.

THE EFFECTS OF ELECTRO-MAGNETIC FIELDS INDUCED BY THE 110 KV POWER VOLTAGE LINES OF 50 HZ ON POPULATION

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The Electro-magnetic radiation of the frequency of 50 Hz is markedly the most massive polluter, the effects of which are largely felt as in environment so in the households proper.

The undertaken research has tasked itself with evaluation of the doings of the alternating low-frequency Electro-magnetic fields in households within the close vicinity to 110 kV Power Voltage lines (PVL) and the assessment of the well-being of the general population as a result of these impacts.

In buildings outlying 10 to 40 meters from the 110 kV PVL source, the level of field intensity topped 180–360 Volt per meter (V/m), whereas the magnetic induction value showed itself as 380–690 nT worth.

The findings of the residents' survey near the PVL source (test group) and farther away (control group) elucidate the following: the PVL impact is felt as disturbing by 48% of the public in test group and only 1% in control group respectively.

The test group highlights a distinctive spread in disturbing elements: psychological discomfort (anxiety and sleep disorders) is named by 40%; buzz and hubbub is a matter of concern with 32% of the respondents; dizziness, headaches and overall tiredness are put forward by 14%; electrization annoys 9% in the group; high voltage is a cause for unrest with 5% of the people.

In buildings close to the immediate PVL installations 75 to 90% of the inner living quarters are under the permanent day-long pressure of the magnetic fields of high level, which is adverse for the health of the people. A number of the people feeling at ease in their impacted homes is 1.6 times lower within test group as comparable to that of the control pool. It is

exemplary that the number of people of the test area relieved while away at work is 4.2 times higher than that of the control group.

The population of the test area under the action of the low-frequency Electro-magnetic fields from the PVL source is 2.3 times more prone to hypertension, 2.5 times to the common cold (flu) and have the overall suppressed low rates of working efficiency and well-being as that of the little impacted control group.

LOW FREQUENCY MAGNETIC FIELDS OF ELECTRIC SEWING-MACHINES

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Studying the influence exerted by the magnetic fields from electric sewing-machines on female organism is one of the aspects in the problem of electromagnetic radiation which are investigated insufficiently. At the same time there are reports about the influence of the electromagnetic fields generated by motors of sewing-machines on the reproductive function of female organism (Robin Herbert, Rebecca Plattus, 1998).

Shops of modern sewing productions are equipped with home and import electric machines worked by synchronous and asynchronous motors. The type of an electric motor corresponds to the class of machines. The power of motors is within the limits of 0.2–0.37 kW. Usually sewing-machines are placed along a conveyor, working places are situated near electric motors at the distance of 0.15–0.4 m. Measurements of the magnetic fields at the working places were made from eight types of electric motors in the process of performing the different working operations. Analysis of the results obtained in the study showed that each working operation was characterized by its own amplitude and form of the non-stationary variations of magnetic fields. The levels of the magnetic field variations at the working places were in the range of 400 nT – 7000 nT. The exposure along the body of the workers was not even, the maximum values were registered around legs, feet and reproductive organs. In the spectral analysis the considerable density of harmonics lower than 2 Hz is a common indication for all measurements. Analyzing the dynamic spectra of the magnetic field variations for the working places tested is evidence that the upper limit of the frequency range is 20 Hz. It should be also mentioned that the level of the low frequency magnetic field components

is considerably higher than the level of the magnetic component of the industrial frequency (50 Hz).

The obtained data are evidence that it is necessary to study the influence of the magnetic fields generated by motors of sewing-machines on the specific functions of female organism.

THE INFLUENCE OF THE TRANSMISSION LINE ELECTROMAGNETIC FIELD UPON FRESHWATER MOLLUSKS' POPULATIONS

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The problem of electromagnetic pollution of the environment is quite topical nowadays. Still the research in this sphere refer mainly to a human being, whereas electromagnetic impact to natural ecosystem seems no less important. The aim of this work was to find out if the radiation of the transmission line crossing the river influenced upon any characteristics of vital functions of the freshwater mollusks which are the typical specimens of water biocoenosis.

Number of animals near to the source of radiation and their age determined according to size of a bowl were investigated. Some sites in various distances from the transmission line were surveyed: 0, 80, 120 and 250 m both upwards and downwards of the current. Mollusks caught in a distance - in 1500 m from the line – were considered as a control.

The following results were obtained. Maximum age of the mollusks was 6–7 years old. Number of animals on control marks was 248 individuals /m² and representatives of all age groups were revealed there. Mollusks' number near to the source of emission depended on distance and it was maximum in the radius of 120 m: on the 0 m mark – 612 individuals /m², 80 m – 735 individuals /m², 120 m – 701 individuals /m²; and it was minimal on the 250 m mark – 210 individuals /m². So it may be guessed that this factor is attractive for the mollusks. As for the age, 3–5-years' old animals formed the overwhelming majority, this tendency keeping outside the dependence on distance. The younger (1–2-years' old) and the older (6–7-years' old) individuals practically were not found, probably for these age classes are quite vulnerable for electromagnetic influence.

The data obtained make the base to consider that the transmission line electromagnetic field negatively influences upon the freshwater mollusks' populations.

ELECTROMAGNETIC FIELDS AND RAILWAYS

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During operational activity of a railway transport in particular of electrified iron roads, one of the unfavorable physical factors of environment are the electromagnetic fields (EMF), introduced in a broad band of frequencies – from units of Hz up to tens of GHz. From the point of view of electromagnetic safety the greatest attention is necessary to pay on the EMF of ultra low frequency range created by systems of electrical link, composite spectral content and non-steady nature of which can have greater ecological and hygienic importance, than well enough studied sinusoidal fields of the frequency 50/60 Hz. Comparing with other sources, EMF of the electrified iron roads influence not only on the enginemen of locomotives and passengers, inside the coaches, but also on the other objects situated apart to 50–100 m from a railway, though that the intensity, the radiation time and the nature of a signal in these cases can considerably differ. The existing gap between the experimentally obtained results and analytical investigations is specially expressed for pseudo-steady ultra low frequency EMF with predominance of the magnetic components in a signal, the orientation and variations in time of which brings composite character. The integrated estimation of biological effectiveness of such kind of EMF is more impeded by their low intensity (from units up to hundreds μT), and also by the depending on systems of the thrust delivery of energy – direct or alternating current (for example, 16.67 Hz in Switzerland, Sweden, Austria or 50/60 Hz in other countries) – the primary characteristics of fields essentially differ.

The results of measurements and the analysis of the items of the information on this problem taking place in Russian and foreign literature are introduced, and also the probable gears of biological effect are performed.

EVALUATION OF RADIO FREQUENCY RADIATION (RFR) FROM TV AND RADIO ANTENNAS AT A PILOT REGION IN TURKIYE

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While the world has been developing policies for protection from Ionizing Radiation, Non-Ionizing Radiation (NIR) have become a portion of our daily life and they created a new concept such as health hazards of NIR and protection approaches. Power lines, electronic equipment used at homes and offices, TV and radio transmitters, electric trains, mobile phones, base stations, radar systems, microwave ovens, satellite systems, solarium machines (sun lamps), medical applications such as MRI and diathermy units etc all are all NIR sources and most of these sources radiate RF energies.

In this study, the calculation of RFR (Radio Frequency Radiation) in a chosen pilot area is realized first time in our country. We calculated RFR at Yenimahalle Şentepe – Dededoruk Hill in Ankara which have 64 different TV and radio towers and one base station. Using the technical data obtained from RTÜK (Radio and Television Top Committee) and Yenimahalle Municipality, we have found that at the region the radiation is more than 400% higher than the permitted standards of Turkiye, although the base station and some of TV and radio transmitters are not included in the calculations, since their technical information were not available. It was observed that there are no warning signs, fences etc. around transmitters except the ones belonging TRT (Turkish Radio Television). Most transmitters are settled near homes and their height are found insufficient.

Urgent precautions should be taken at Yenimahalle Şentepe – Dededoruk Hill related with RFR. The region should be analyzed with a new approach, like moving all the antennas to another region and sharing the same tower for more than one antenna instead of putting tower for every antenna etc.

In all over the world, besides putting the RF standards, there should be internationally accepted rules about sitting radio and TV towers and base stations, such as minimum distance from the places where people live, height of the towers, warning signs, sharing of a tower for more than one antenna etc.

THE ELECTROMAGNETIC SITUATION IN UNDER-DECK PREMISES OF SHIPS

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The purpose of this study included measurements of the low frequency electric and magnetic fields and the hygienic assessment of their influence on the crew of ships. Studies of EMF in the under-deck premises were performed on eight ships of the different type and purpose (ice-breakers, dry-cargo ships, a ferry-boat, passenger ships etc.). The main sources of the low frequency EMF in the under-deck premises of ships are electric power systems (sources and consumers of the electric power, long cable lines). EMF were registered in the premises of the central control post at the working places of a mechanic, near the control desk of propeller power drive, in the main engine-room, in the department of stern engines, in the deckhouse, in premises of propeller engines, in the cabins of the ship crew, in the premises of the workshop. Measurements were made in the process of sailing with different current loads of the equipment and at the ship's moorings. Measurements were performed with the help of the magnetometric complex allowing to register magnetic fields on the real time scale, teslameter "Heba-4", the measuring instrument (type ПЗ-50) for electric and magnetic fields of the industrial frequency (50 Hz). Basing on the obtained data the charts showing the distribution of the magnetic fields in different premises were worked out. It was revealed by the studies that the levels of the industrial frequency electric fields in the cabins and at the working places did not exceed 100 V/m. The highest induction levels of the industrial frequency magnetic fields were registered in the premises of the central control desk, they reached 11 μT . Considerably more high induction levels of the magnetic fields were registered in the frequency range of up to 20 Hz. So, in the engine-room the induction levels of the magnetic fields in this frequency range reached 200 μT , in the premises of static transformers they were 50 μT . In the premises of the central control post the MF induction levels were within the limits of 11.4 to 106 μT .

In order to protect crew of ships from the influence of magnetic field (the frequency up to 20 Hz) it is necessary to develop proper hygienic standards.

MORTALITY STUDY ON RADAR SOLDIERS IN GERMANY

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Public interest in possible health effects from radar appliances is growing rapidly in Germany. Main contribution to this topic comes from actual or former soldiers entrusted with repair, maintenance or even operation of military radar. Several legal proceedings were handled at German courts to clear claims for compensation of impaired health. Two exposure factors were regarded as responsible: ionizing and non-ionizing radiation. Ionizing radiation comes from x-ray emitting cathode ray tubes in the generator and from radioactive markings on controls. Non-ionizing radiation is emitted from the antenna, typically pulsed and in the GHz frequency range.

We conduct a mortality study to check for indications of severe health risks at radar work places. For a random sample of 4000 radar soldiers out of 23.000 identified exposed persons and a control group of same size the vitality status has to be cleared. This is conducted by two ways: 1. A posted questionnaire to both groups, mainly to identify living persons and 2. a subsequent inquiry at the local registry offices for those persons who did not return the questionnaire or who were not reached by mail.

The questionnaire shall enlighten to some part the workplace situation of radar soldiers with respect to possible cofactors in early times of the German Bundeswehr as experienced by the soldiers. It will also provide additional information to the question of elevated numbers of diseased persons in comparison to the soldiers not exposed to radar.

The study is in progress and right now the response of the mailing is still arriving. Preliminary results will be presented at the meeting.

8. EMF STANDARDS AND HARMONIZATION

PROBABILISTIC PRINCIPLE OF ELECTROMAGNETIC STANDARDIZATION

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Many experiments show that weak and even hyperweak EM fields can influence living tissues and whole organisms. Theoretical approaches also indicate that EM fields — even when they are too weak to heat tissues — may result in a variety of different biological effects, some useful and some probably noxious. To date, the physical nature of the biological sensitivity to weak and hyperweak EM fields remains unclear, although significant insight has recently been developed [V.N. Binhi. *Magnetobiology*. Academic Press, San Diego, 2002] concerning the non-thermal action of EM fields. This theory is based on primary physical principles and agrees with experiments. In many cases, biological effects display “windows” in biologically effective parameters of the fields. Most dramatic is the fact that relatively intense fields sometimes do not cause appreciable effect while smaller fields do. Linear resonant physical processes, as well as any kind of heating, cannot, of course, explain the existence of frequency windows. Such findings undermine the philosophy on which most of the existing EM safety standards are based — namely that EM fields can lead to biological effects only if they cause heating of biological tissues. Therefore, in occupational and residential activities, people exposed to EM fields from industrial and domestic appliances, conform to existing safety standards, are still vulnerable to non-thermal biological effects having possible adverse consequences for human health. This is why a totally different approach must be adopted if people are to be protected against cell phone radiation and other forms of sub-thermal EM environmental pollution. More perfect EM safety standards concerning non-thermal EM intensities are to operate with probabilities of general noxiousness related to EM exposures rather than with the allowable levels of those exposures. In EM standardization, that means that the cause-effect approach originated from thermal bioeffects should be replaced by the probabilistic approach allowing for the given sort of exposure either can or cannot cause a severe health consequence. Since such a resonant EM bioeffect depends on many parameters of EM exposure and on the physiological state of human beings, and since the bioeffect finds suitable mathematical description, there is a convenient opportunity to use probabilistic approach and calculate probabilities of harmful bioeffects mak-

ing use of mathematical treatment based on averaging over a number of relevant EM parameters.

UPDATE OF IEEE C95.1 – 1991 RF SAFETY STANDARD REVISION

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The IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz (C95.1–1991) was published in 1991 and reissued in 1999 with a number of changes. The exposure limits, however, which are based mainly on scientific information reported before 1986, were not changed. Soon after the standard was approved in 1991, Subcommittee 4 began an extensive literature evaluation as part of the revision process. Most of the studies in the current database of 1593 references have been assigned to one of four categories: engineering, in vitro, in vivo, and epidemiology. Each paper is evaluated by two randomly selected members of the engineering evaluations working group and by two members of the appropriate biological evaluation working group. In parallel, white papers have been written to cover topics on: cancer, reproduction, calcium efflux, behavior, thermoregulation, nervous system, ocular and auditory effects, homeostasis and metabolism, longevity, epidemiology, in vitro studies, and one vs two tier standard. As reviews are completed, summaries thereof are forwarded to the Risk Assessment Working Group (RAWG), whose charge is to evaluate the levels of possible risk to humans, and define the lowest threshold SAR above which potentially deleterious effects are likely to occur. The white papers also are cross-checked against the literature review results. A Mechanisms Working Group, working in parallel with the RAWG, is evaluating possible mechanisms of interaction between electromagnetic fields and biological entities, as well as whether there is any scientific basis for reports of the existence of effects at levels well below the lowest threshold SAR.

The Revision Working Group has met five times. A first draft of the revision will be discussed by the subcommittee in June, 2002. IEEE safety standards are developed through a fully documented and open consensus process. Broad scientific consensus and involvement of all interest groups are essen-

tial. Currently, there are 115 members from 21 countries with affiliation in government, academia, industry or consulting. The draft must be approved first by at least 75% of the voting subcommittee members, and then 75% of the parent committee members after circulation of negative ballots. The goal is to develop scientifically based exposure criteria that ensures, with an adequate margin of safety, that known thresholds for adverse effects are not exceeded.

THE RESTRICTION OF RADIOFREQUENCY ELECTROMAGNETIC FIELD (RF EMF) IN GENERAL PUBLIC OF RUSSIA: RETROSPECTIVE SURVEY AND CURRENT VIEWPOINT

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When developing methodological approaches to EMF restriction, several groups of hygienic researchers have participated including Kiev Institute of General and Municipal Hygiene named after A.A. Morzeyev (Ukraine), Moscow Institute of General and Municipal Hygiene named after A.N. Sysin (Russia), Moscow Institute of Labor Hygiene and Occupational Health (Russia), Moscow Hygiene Institute named after F.F. Erisman (Russia), Kharkov Institute of Labor Hygiene and Occupational Health (Ukraine) and other.

The concept of the permissible level of EMF for general public has been adopted. The plan of comprehensive experimental studies to obtain data justifying EMF permissible levels has been developed and realized.

The medical hygienic studies has been elaborated at industrial enterprises of rather high EMF levels.

Currently, our knowledge on the health effect mechanism of RF EMF of low intensity confirm the justified strict acting standards imposed in Russia. In such circumstances the developers take into account the condition of social stress affecting in Russian population together with the exposure to EMF of different frequencies and modulations including electromagnetic radiation of novice sources like base stations of cellular communication as much as the public exposure to different chemical and physical factors.

BROADBAND QUASI-CONTINUOUS ELECTROMAGNETIC FIELDS: POSSIBLE STANDARDIZATION CRITERIA AND ROLE OF BACKGROUND

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The progressively growing electromagnetic pollution of an environments created by numerous sources of the most different character and with the diversified form of electromagnetic oscillations begins to lead to situation that frequency spectrum of EMF background becomes quasi continuous. In this case, the exposure D resulting by this background (in terms of MPE) can be presented as the contribution of set of virtual sources, namely:

$$D = \int_{f_{min}}^{f_{max}} \frac{1}{\Delta(f)} \cdot \varphi \left(\frac{G(f)}{G_L(f)} \right) \cdot df \quad (1),$$

where G – parameter of the field (E, H or S) as function of frequency f ,

$G_L(f)$ – MPE, $\Delta(f)$ – resolution width of an equipment serving for $G(f)$ measurements, φ – some function.

If sizes of Δ_n and $G_{L,n}$ do not depend from f in the appropriate frequency ranges $f_n - f_{n+1}$, the expression (1) passes to:

$$D = \sum_{n=1}^m \frac{1}{G_{L,n} \cdot \Delta_n} \cdot \int_{f_n}^{f_{n+1}} \psi(G(f)) \cdot df \quad (2),$$

where m – quantity of intervals of splitting.

It is logical to accept for not thermal model in the case E and H that $\varphi(G(f)/G_L(f)) = G(f)/G_L(f)$ and $\psi = G(f)$. For thermal model, as it is usual, $\varphi(G(f)/G_L(f)) = G^2(f)/G_L^2(f)$ and $\psi = G^2(f)$.

The modeling calculations show what even in that case, when the background quasi-continuous is far less MPE, it can create appreciable exposure. So, for example, place the size of an electrical component of the quasi-continuous background is four order (i.e. on 80 decibel!) lower then MPE determined by National Russian Standard (GOST) R 50804-95 (1995) “Environment of a cosmonaut in a manned space vehicle”. At enough reasonable assumptions the exposure result from such background in the range 0.01 – 300 MHz is about 0,6 MPE. In the range 300 – 1000 MHz, where according to GOST R 50804-95 power density (S) is limited, the quasi-

continuous background, which is on 80 decibel lower MPE, the contribution the exposure greater then two MPE.

In connection with above-stated we shall touch the widespread error, that if electromagnetic conditions meet the requirements of electromagnetic compatibility of the equipment, these conditions so especially should meet the requirements of bioelectromagnetic safety.

Put, for example, the electrical component of the quasi-continuous background is three order (!) lower then values which fit the requirements of electromagnetic compatibility of equipment for the Russian Segment of International Space Station, the contribution of this background into the exposure in a range 0.01 – 300 MHz will be about 1.3 MPE and in a range 300 – 1000 MHz ~0.65 MPE.

The similar meanings take place for thermal model of influence, when an electrical component of a background quasi-continuous is lower MPE on two order. In existing practice of an estimation of electromagnetic safety such sizes of background are not considered at all.

In the given approach basically it is possible to take into account probable compensating action of various parts of the EMF spectrum and also effects of their synergism.

It is represented to us, that the expansion of theoretical and experimental research is necessary, as well as use of the equipment recording amplitude-frequency the characteristics of EMF in a wide range with sensitivity much higher MPE at estimations of electromagnetic safety.

QUESTIONS AND ANSWERS CONCERNING STANDARD HARMONIZATION PROCESS IN EASTERN EUROPEAN COUNTRIES

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Many differences exist between the schools of developing standards for radiofrequency human exposure in the “east” and “west” countries: different criteria for the exposure limits, terminology, definitions of adverse and biological effect, long term and short term, nonthermal and athermal effects, safety factors, etc. There are also differences in the philosophy of the biological limits for radiofrequency exposure between different groups of specialists in West and East. The political barrier between the researchers 10 years ago led to a great misunderstanding.

Our viewpoint is that there are not so big differences in the rationales of standards between the two schools, more often it seems to be a kind of disagreement or misunderstanding. That is the reason to start a short-term project for standard harmonization, mainly for the East countries.

The purpose of our study is to find a way for reaching an agreement between different schools for developing standards, and more precise: to find how the specialists from West Europe, USA, Canada, Japan, etc. to understand the criteria of the East European standards. The main purpose is to know what is the personal opinion on the framework for standards proposed as a part of the International EMF Project.

According to the research program we developed a questionnaire aiming to create a working group dealing with standards from the east countries, and being representatives of this school in the standard harmonization process worldwide. This questionnaire could give us a basis for replication of some research studies with a good design carried out in the past. Finally, this is a good solution for understanding and accepting other criteria for exposure limits.

Our information is based on the answers from Bulgaria, Czech Republic, China, Hungary, Poland, Russia, Turkey, Serbia. It includes database of specialists dealing with standard development, history of setting standards in every country, ideas for developing exposure limits, papers for replication, personal opinion on different questions as terminology, criteria for exposure limits, about ICNIRP guidelines, also suggestions for standard harmonization.

We hope that this work will serve for the WHO idea for reaching an agreement on standard harmonization worldwide.

EXPERIMENTAL GROUNDING OF HYGIENIC STANDARDS FOR 3–30 MHZ ELECTROMAGNETIC FIELDS

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The results of chronic radiofrequency range EMF bioeffects study are reported. The research was carried out in Leningrad Scientific Research Institute of Industrial Hygiene and Occupational Diseases (Since 1998: North-West Public Health Research Center).

The developed experimental model is based on hygienic assessment analysis of parameters of electromagnetic radiation generated by marine radio communication equipment on board the ships of different purpose, by radio-

transmitting centers and in industry. A bench facility designed specially for animal experiments (male rats) allowed to simulate personnel occupational exposure conditions close to reality concerning EMF intensity and frequency range. The bench facilities provided EMF intensity levels in 50-1500.0 V/m operating range. The bench facilities made it possible (depending on the study aims) to expose animals to non-modulated or code-modulated EMF in 3–30 MHz range. In the latter case a special key-imitator was designed to simulate the telegraph key operation. Basic and control group animals were enclosed into individual plexiglass cages. Chronic experiment durations were 2 or 4 months. Animals were surveyed for a month after the exposure had stopped. Each experimental series had got its own animal control group. Animal behaviour, endocrine and reproductive system states were studied. Biochemical and hematological blood parameters were taken. Pubertal animal state was assessed according to 25–42 indications.

Physical development parameters, ossification rate change, pathological developmental changes of internal organs, preimplantation deaths were assessed in exposed male offspring. In postnatal development period we assessed physical developmental indicators, sensory and locomotor responses formation rate and progeny mortality. The findings of our studies were used for grounding of maximum allowable levels of high-frequency range electromagnetic fields exposure of personnel.

STATE AND PROSPECTS OF ELECTROMAGNETIC FIELD HYGIENIC STANDARDIZATION IN RUSSIA AT THE PRESENT STAGE

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The urgency of general public electromagnetic safety in Russia grows in connection with increased electromagnetic pollution of an environment as for the account before widespread power and radio engineering objects, radar systems, means of navigation and communication, and modern sources of electromagnetic fields (EMF), which have received wide development, such as computer, means of a cellular and satellite radio communication.

In a basis of EMF hygienic regulation the principle of exception of their adverse influence on health of the present and subsequent generations is incorporated. A basis of a regulation is the complex hygienic, clinical, physiological, experimental, epidemiological researches and knowledge of the basic

mechanisms of biological effects of the factor. In Russia are available the hygienic rules EMF occupational and general public exposure in a range of frequencies from static electrical and magnetic fields and power frequency EMF up to 300 GHz, including EMF from devices of mobile communication, methods of the control, methods and means of protection, the preventive measures are offered.

Questions of an estimation of chronic exposure effects on human health, low intensity EMF effects of various frequency ranges, significant in biological effects of magnetic component, pulse and faltering modes of radiation, modulation, estimation of the combined action of different frequency EMF ranges and in a combination to other factors of environment however are non sufficiently developed. Both in domestic, and in the foreign literature there are no necessary generalizations on this question.

The most urgent questions are as harmonization of the available standards with foreign, and realistic hygienic rating of power frequency EMF magnetic component for the population, EMF from computer systems (not by criteria of the standard technical achievement), perfection of the rules of mobile communication EMF (in view of prospects of its development).

FRAMEWORK FOR INTERNATIONAL EMF STANDARDS

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Globalisation of trade and the rapid expansion of use of electrical devices and use of the whole electromagnetic spectrum, especially for telecommunications, have focused attention on the large differences existing in standards limiting exposure to EMF. WHO's International EMF Project has been promoting the concept of harmonization of international EMF standards through a number of key activities:

1. A series of regional meetings in each of the 6 WHO regions, so that scientists in those regions would have an opportunity to provide reviews their scientific studies and to contribute and discuss what regional scientists feel comprises the essential components of an international EMF standard.
2. Compiling all ideas on standards from regional meetings into a "framework" document that will form the basis of an internationally agreed standard.
3. Providing the facility for countries to reach agreement of EMF standards through ad hoc EMF standards committee meetings.

4. Hosting an international meeting with the purpose of reaching agreement on the EMF standards framework.

Much of the standards framework incorporates concepts normally used by WHO and particularly ICNIRP, who develop international standards that have been accepted by a large number of national authorities, including the European Commission. If countries feel the need to develop their own EMF standards, it is hoped that the framework would serve as a basis for their standards where incorporation of the results of WHO's health risk assessment process could be used to determine values for exposure limits.

This paper will review WHO's activities on standards and summarize the elements of the framework for standards.

EXECUTED IN 70-TH YEARS EXPERIMENTAL RESEARCHES OF BIOLOGICAL EFFECTS OF INTERRUPTED MICROWAVES FOR HYGIENIC NORMS SPECIFICATION

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Proceeding from results of hygienic researches according to parameters of microwave (MW) exposure to workers in experiment on animals with the purpose of an establishment of a threshold of harmful effects comparative research of biological effects of 3 GHz interrupted microwaves exposure with 60-320 $\mu\text{W}/\text{cm}^2$ power density and 3 GHz continuous MW exposure with power density 150 $\mu\text{W}/\text{cm}^2$ is carried out at 1 hour duration of a real exposure for a session in conditions of chronic experiment at general exposure time influences about 7 months.

At research of changes of weight of a body, arterial pressure, a functional state of the central nervous system (on EEG parameters reactions on epileptogenic sound irritation) and to morphological changes of structures of a brain; terms of destruction of animals at strychnia poisoning, immunological, biochemical and endocrine parameters the big biological efficiency of interrupted exposure was shown in comparison with continuous.

On the basis of the received data the conclusion about specification of maximum permissible levels of microwave occupational exposure was made.

THE RESULTS OF THE CHRONIC EMF EXPOSURE OF ANIMALS (850-2750 MHZ) IS THE BASE MATERIAL TO MOTIVATIONS OF THE STANDARDS FOR POPULATION

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Proceeding from the actually existing dynamic range of this factor in the environment, as well as considering the requirements of the chosen experimental plan and technical capabilities, we studied the biological effects of a pulsed intermittent microwave EMF at the following levels of energy flux density 20, 50, 100, 500, 2500 mW/cm² with 16-h daily exposure for 4 months.

Animals were irradiated in anechoic chambers made of radiowave-absorbing material. An electromagnetic complex, with controllable energy output, operating at a frequency of 850, 1310, 1760, 2750 MHz with pulse frequency of 400 Hz.

Investigation of the effects on white rats of a pulsed intermittent electromagnetic field on the basis of physiological, hematological, immunological, biochemical and reproductive parameters.

In addition, we should mention that there were changes in the animals referable to the central nervous system, the functional state of which was evaluated from parameters such as electrocutaneous sensibility, exploratory and motor activity, intensity of conditioned defense reflex. The results of these studies enabled us to determine that an intermittent pulsed electromagnetic field elicits elevation of parameters of electrocutaneous sensibility and some changes in parameters of conditioned defense reflexes of experimental animals.

In addition, in our study of immune resistance we found certain changes in animals exposed to EMF. The decline of complement activity in the first months of exposure could apparently be indicative of complement tension of the humoral element of natural immunity.

The results of these studies revealed that an intermittent pulsed EMF elicited an increase in experimental animals' blood sugar, blood serum and residual nitrogen, with decline of organ glycogen levels, depression of mitochondrial succinate dehydrogenase and cytochrome oxidase activity, increase in blood serum metalloenzymes-ceruloplasmin and transferrin.

Reproductive function is an important indicator of functional state of an organism. The results of our studies revealed that EMF of the tested EFD levels had an adverse effect on some parameters of this function.

However, we found that there was a longer interval between mating and birth of offspring. The number of rats per litter was increased in this case, but they were less viable. We demonstrated differences in weight and linear parameters at birth and in the course of postnatal development. The developmental deviations consisted of delayed weight gain and growth of trunk, slower development of pelage and later opening of the eyes.

We see from the experimental results that embryo mortality was reliable greater at EMF than in the control.

Thus, the experimental data revealed that long-term exposure to EMF of 850-2750 MHz at different EFD levels elicits disturbances in reproductive function of experimental animals. As a rule, their severity depended on energy flux density.

After termination of the biological experiment, we submitted the results obtained from all the tests used to statistical processing, after which we processed by the method of regression analysis the parameters that showed deviations from the control that were statistically reliable according to Student's criterion.

As we analyze the results of biological studies in the aspect of "level-time-effect", it should be noted that the changes in different biological substrates depended on the intensity of the factor and duration of exposure.

The results of this analysis revealed that EFD would not elicit statistically reliable changes in any of the tests we used. Consequently, according to our data, is the maximum ineffective level of an intermittent pulsed electromagnetic field of 850-2750 MHz.

9. DIAGNOSTICS AND THERAPY WITH USE EMF

USING OF MAGNETIC IN REHADILITATION OF PATIENTS SUFFERING ISCHEMIC HEART DISEASE DURING HOSPITALITY TREATMENT PHASE

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Objective: to study the impact of the compination of rehabilitation process by using the magnetic in the case of oxidation of fats and interior intoxication for the ischemic heart disease patients with postinfarction cardiosclerosis and circulatory insufficiency (I–II). The research covered 31 patients who wered examend. They were given the traditinal therapy compined with magnetic. In addition there are 9 patients suffered the same situation and on the same age group were given traditinal medicine. Examinations – general clinical, electrophysical, biochemical – MDA in plasmaand erythrocytes, (IMP)-282 and 286, cathalase. Results: the main group examened and treatment with magnetic resulted obiously in decrease of MDA from 3.87 ± 0.13 before treatment to 2.73 ± 0.21 after treatment ($P < 0.001$) and MDA in erythrocytes: from 49.7 ± 1.5 before treatment and 42.6 ± 2.2 after treatment ($P < 0.001$). The level of cathalase increased from 186.5 ± 4.7 to 218.4 ± 4.2 after treatment. Level of IMP 282 decreased from 0.368 ± 0.011 to 0.280 ± 0.020 IMP 286 from 0.450 ± 0.018 to 0.330 ± 0.019 ($P < 0.05$). While the control group result was not confirmed. In parallel the main group condition was improved possitively. The magnetic proven that it helps in improving the patient condition and redusing interior intoxication.

LOW-AMPLITUDE, EXTREMELY LOW FREQUENCY MAGNETIC FIELDS FOR THE TREATMENT OF OSTEOARTHRITIC KNEES: A DOUBLE BLIND CLINICAL STUDY

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Context * Noninvasive magnetotherapeutic approaches to bone healing have been successful in past clinical studies.

Objective * To determine the effectiveness of low-amplitude, extremely low frequency magnetic fields on patients with knee pain due to osteoarthritis.

Design * Placebo controlled, randomized, double-blind clinical study.

Setting * 4 outpatient clinics.

Participants * 176 patients were randomly assigned to 1 of 2 groups, the placebo group (magnet off) or the active group (magnet on).

Intervention * 6-minute exposure to each magnetic field signal using 8 exposure sessions for each treatment session, the number of treatment sessions totaling 8 during a 2-week period, yielded patients being exposed to uniform magnetic fields for 48 minutes per treatment session 8 times in 2 weeks. The magnetic fields used in this study were generated by a Jacobson Resonator, which consists of two 18-inch diameter (46-cm diameter) coils connected in series, in turn connected to a function generator via an attenuator to obtain specific amplitude and frequency. The range of magnetic field amplitudes used was from 2.74×10^{-7} to 3.4×10^{-8} G. with corresponding frequencies of 7.7 to 0.976 Hz.

Outcome Measures * Each subject rated his or her pain level from 1 (minimal) to 10 maximal) before and after each treatment and 2 weeks after treatment. Subjects also recorded their pain intensity in a diary while outside the treatment environment for 2 weeks after the last treatment session (session 8) twice daily: upon awakening (within 15 minutes) and upon retiring (just before going to bed at night).

Results* Reduction in pain after treatment session was significantly ($<.001$) greater in the magnetic-on group (46%) compared to the magnet-off group (8%).

Conclusion * Low-amplitude, extremely low frequency magnetic fields are safe and effective for treating patients with chronic pain due to osteoarthritis.

USE OF A MAGNETIC FIELD FOR IMPROVEMENT OF NERVOUS ALLO- AND XENOGRAFT SURVIVAL AND FOR CORRECTION OF BEHAVIOUR OF THE RATS-RECIPIENTS

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Study of influence of a low-frequency variable magnetic field (MF: 50 Hz, 40 mT) on survival of xenografts (XG) was carried out after the transplantation of a brain tissue of an 18-day's chicken into the brain of the rats-recipients. MF influenced on a brain of the rats-recipients with XG or on a donor tissue before the transplantation. It was shown, that the MF action on a rat brain with XG (during 1 hour for 1, 3 or 5 days) resulted in significant easing or prevention early (5 days) rejection of grafts, considerably expressed in control group without MF action. Also it was revealed, that the preliminary influence of MF no more than 1 minute on a donor tissue prevented the rejection of XG within 40 days after surgery. At the same time influence of MF during 30 minutes on an egg with the chicken embryo in many cases caused the rejection of XG, allocated from this embryonic brain, and expressed glial reaction in a host brain.

The influence of MF during one hour on a brain of the rats-recipients with the allografts in epileptogenic kainate region promoted normalization of the disturbed behaviour of rats in open field and in shuttle chamber in comparison with the control rat groups (with kainate damaged brain without allografts or with them, but without MF action).

Performed researches testified to an opportunity of MF use for improvement of the graft survival and the correction of the disturbed behaviour of the animal-recipients.

PULSED MAGNETIC FIELD APPLICATION TO RECOVER ORGANISM FUNCTIONS AFTER RADIATION INJURY

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As of today, it was proven that metabolic and functional properties of certain biological systems might be modified considerably due to exposure to weak (up to 10mTl) electromagnetic fields (EMF), which are the most physiological for human organism and therefore provide an opportunity of effecting upon all the organism's structures.

Pathology zone EMF exposure is being optimized in RFNC-VNIIEF, where it is developed a technology based on the fluctuation theory of stable non-equilibrium systems exposed to external factors. Spectral function of cardiac beat fluctuation was taken as the theoretical basis for choosing effective pulsed EMF parameters. It was developed a set of EMF exposure layouts aiming at recovery of normal organism functions.

The layouts trial with hybrid mice F1 9CBAxc57 BL/6) showed that the magnetic field suppresses tumor cells growth (lungs carcinoma by Lewis). A 10-day EMF exposure practically did not influence upon the primary tumor growth (6.3–6.1 g) but caused a considerable decreasing of metastases (20.4–7.5 nodes respectively).

The EMF layouts clinical testing demonstrated that the magneto-therapeutic effect bears a multi-functional nature. EMF serves as the immuno-modulating and adjuvant tool and therefore suits to treating diseases of different patho-physiological character.

Basically, the results obtained might serve as a scientific basis for EMF treatment of professional diseases, as well as for EMF general therapy of radiation injuries.

DISTRIBUTION DENSITY OF CARDIAC BEAT FLUCTUATION AS OBJECTIVE INDICATOR OF ORGANISM CONDITION

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The present paper covers experimental data on cardiac beat fluctuations of white non-breed rats, which stay in a quiescent state.

The goal of the work was to clarify general regularities in the cardiac beat variation, which would be characteristic for all higher-order animals and human beings exposed to external man-caused factors.

The cardiac beat fluctuation was estimated based on a systematic analysis of an electro-cardiogram for the animal resting in a quiescent state. The following techniques were used: histo-graphic; cardiac intervals recording; spectral and statistical methods.

The following conclusions were made:

Temporal function of the cardiac beat fluctuations, as well as frequency representation of RR-intervals variance, are strictly individual for each animal;

Individual variability of the rats' breathing waves frequency is 2 Hz;

Chaotic cardiac beat fluctuations for the entire investigated group (of rats) fit within the same statistical regularities

It was shown that the outline of the fluctuation distribution density function for rats in a quiescent state, and the outline of chaotic fluctuations of a practically healthy person in similar state correspond to the model $U(f)=A f^{-n}$.

The index "n" is 0.8–1.5 for rats, and 0.8–1.4 for a human being. If n is equal for a person and a rat, the factor "A" value for a rat will be always less than for a person.

PULSATING MAGNETIC FIELD AS A USEFUL MODALITY IN BIOLOGY AND MEDICINE

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Background A number of beneficial effects of extremely low frequency electromagnetic fields (EMF) have been reported in the last two decades, especially in the treatment of musculoskeletal disorders and pain. However, most modalities suggested for clinical use went to the market without a detailed physical and biological screening.

Therapeutic electromagnetic field (TEMF) This paper shows a systematic evaluation of biophysical, biological and clinical responses to applied pulsating electromagnetic fields. Pulsating electromagnetic field stimulation, as delivered by a proprietary technology (TEMF) designed and developed by EMF Therapeutics, Inc. (Chattanooga, TN), is a new treatment option being evaluated for various biological and clinical applications. EMF

subject of this presentation were generated by two modifications of the TEMF-005 device. The signal consists of a 120 pps fully rectified semi-sine wave. The rectified semi-sine wave maximums with magnetic flux density of 0–25 mT were separated by 4 ms (Signal 2) or 8 ms (Signal 1) DC components which varied due to the presence of different components in the electrical circuit of the generating system.

Biological response was evaluated by using cell-free myosin phosphorylation, a chick embryo explant model, normal and inflammatory T lymphocytes, and vascularization and tumor growth in animal tumor models. Clinical response was evaluated in a double blind clinical study of chronic low back pain.

Myosin phosphorylation The cell-free reaction mixture for myosin phosphorylation is described elsewhere. The enzyme-substrate assay involves myosin light chain (MLC), myosin light chain kinase (MLCK), calmodulin (CaM), radioactively labeled ATP and an appropriate concentration of calcium ions. The reaction solution was exposed to TEMF at temperature of 37° C and the reaction was run for 5 min. The Cherenkov emission method was used as a read-out method for evaluation of the level of ³²P incorporation in MLC.

The myosin phosphorylation model was used to evaluate a large range of amplitude and frequencies in order to assess the signal configuration which initiate the most pronounced response. In the range of 5–25 mT the myosin phosphorylation assay shows a maximum response at 15 mT magnetic flux density. This response is not significantly different when comparing signal 1 and signal 2.

Nerve regeneration A chick embryo explant model was used to assess bioeffects by measuring various areas of neurite growth in cultured chick embryo dorsal root ganglia (DRG). In all experiments, 3–30 ng/ml nerve growth factor (NGF) was included in the culture medium since NGF is essential for normal growth and differentiation of sensory neurons. On each surgical day DRG were dissected from 9–10 day old chick embryos and placed in 60 mm collagen-coated culture dishes containing 3 ml Neurobasal medium plus a serum-free mix of growth substances (Sigma Corp). In each experiment five to seven DRG in each of 4–6 culture dishes were exposed to either Signal 1 or Signal 2. Sham cultures were exposed to the unpowered coil. This plan was repeated at least 4 times for each signal. The explants in the dishes were exposed to TEMF fields for 5 or 10 min/day for each of two days and then fixed. The fixed explants were photographed and growth areas assessed quantitatively using an image analysis technique.

Three growth parameters were analyzed for each DRG: total area of the explant, neurite outgrowth area and central neuronal area. Neurite outgrowth area was enhanced significantly when Signal 2 was used for either 5 or 10 min/day exposures. Results showed that growth was increased by 38% ($p < 0.05$) at 5 min exposure, and 50% ($p < 0.02$) at 10 min exposure relative to sham controls at the same NGF concentrations. Total area paralleled results found with neurite area. No differences were found in the central neuronal areas between any groups. In contrast, consistently lower values of neurite outgrowth were found when the DRG were exposed to Signal 1 even though these differences were not statistically significant. Although the distinction between the two EMF signals is small – (4 vs 8 msec delays between semi-sine waves), the resulting differences in bioeffects is interesting and may be important.

Inflammatory lymphocyte model The effects of TEMF on normal and inflammatory T lymphocytes and the potential use of TEMF to treat inflammatory diseases were investigated using human Jurkat cells (E6-1, ATCC). Cells were grown to mid log phase culture in RPMI 1640 containing fetal bovine serum, and replated at 106 cells/ml in 6-well or 96-well culture dishes before use in experiments. Cells were exposed to 5–20 mT TEMF for 10 min at 37°C in three different states: without activation, with partial activation by plate-bound anti-CD3 (10 µg/ml) and with full activation by a combination of plate-bound anti-CD3 and phorbol myristate acetate (PMA, 50 ng/ml). The three cell states were used as models for normal proliferating, apoptotic, and inflammatory T lymphocytes, respectively. Control cultures were placed at areas with DC fields similar to those measured inside the TEMF exposure system, or they were placed inside unpowered coils before or after the experimental samples. Cell proliferation was assayed by 3 hour pulsed [3H]thymidine incorporation into DNA, hemocytometer cell counts and Coulter Counter Model ZM cell counts. Apoptotic cell death was evaluated by measuring caspase-3 activity using a fluorogenic caspase-3 substrate and a Perkin Elmer spectrofluorometer. As an indicator of fully activated, inflammatory T cells, interleukin-2 (IL-2) in cell culture supernatants was quantified by ELISA.

Cell proliferation, caspase-3 activity and IL-2 production of normal inactivated Jurkat cells were unaffected by TEMF of various intensities. TEMF of 15 and 20 mT slightly increased caspase-3 activity and decreased cell proliferation of partially activated/ apoptotic Jurkat cells. In fully activated/ inflammatory Jurkat cells the same TEMF significantly increased IL-2 production up to 2-fold and decreased cell proliferation up to 30%. The TEMF effects were dependent on the cell cycle of the exposed cells. TEMF

do not activate or otherwise alter the activity of normal, proliferating T lymphocytes and only weakly affect partially activated/ apoptotic T lymphocytes. These data indicate that TEMF therapy is not likely to cause inflammation as a side effect. In addition, the results indicate that TEMF therapy would not prevent the natural apoptotic elimination of inappropriately activated T lymphocytes such as might be induced by autoimmune signals. It even appears that TEMF therapy has the potential to slightly promote this negative selection. On the other hand, TEMF strongly affect IL-2 production of inflammatory lymphocytes in the Jurkat cell model. This result indicates that TEMF therapy can be used to modulate inflammation, in accord with our original hypothesis.

Tumor models The animal study explores the effects of daily treatment with TEMF on growth and vascularization of established and measurable murine 16/C mammary adenocarcinomas growing in C3H/HeJ mice. Tumors were allowed to grow for seven days until the tumor mass reached 100 mg before the treatment started. Applied magnetic field intensities were 0, 10, 15 or 20 mT. Animals (10 per treatment group, 20 in the control group) received treatment for 0, 3, 10 or 40 min daily. The fast growth of tumors in the control group limited the length of the experiment to 12 days. The extent of vascularization was evaluated by the expression of CD31 in the tumors. Tumors from all mice were immunohistochemically stained using an antibody against the vascular endothelial cell determinant CD31 and the extent of tumor vascularization, viable area and necrotic area was measured by morphometrics.

The TEMF of 15 mT was shown to initiate the strongest inhibition in both angiogenesis and tumor growth in the range of 5–20 mT magnetic field amplitudes. The magnetic fields significantly reduced the percentage of CD31 staining in the tumors of all three groups: by 39% (at 10 mT), 68% (at 15 mT) and 62% (at 20 mT) thus indicating a reduction in vascularization. At initiation of TEMF treatment, the tumor volumes of all groups were approximately 120 mm³, while the final tumor volume of the control group was 3567 mm³ and the final tumor volume of groups exposed to TEMF was 2945 mm³ (for 10 mT), 2807 mm³ (for 15 mT) and 2563 mm³ (for 20 mT). The necrotic area in the tumors of the control group was 25% and increased to 32% for 10 mT, 42% for 15 mT and 36% for 20 mT treatment. The results suggest that the blood vessel network in the growing tumor is a target for TEMF and that TEMF therapy may be a simple and safe adjuvant to increase the efficacy of conventional therapy for vascularized and growing tumors. In addition, an increase of survival time was found in a separate experiment.

TEMF for low back pain The clinical study proposed 80 subjects be randomly assigned to one of four treatment groups (placebo, 5 mT, 10 mT or 15 mT). Employing a double blind, sham-treatment controlled design, participants were evaluated over six weeks. Subjects completed a two-week baseline period to assess the severity of pain and the use of ancillary medications. They were then randomized to one of four treatment groups (placebo, 5 mT, 10 mT or 15 mT) for six 30-minute treatments over two weeks. This was followed by a two-week follow-up period. Primary outcome measures included a self-report of pain severity using a 100 mm visual analog scale pre- and post-treatment, and completing a twice-daily pain diary using the McGill Pain Questionnaire – Short Form.

An interim analysis of the data collected from the first twenty patients (5 subjects per group) was performed to assess the statistical power of the study and determine if a sufficient numbers of patients were included in the original design to achieve significant results. The interim analyses conducted on both the individual (time-series) and group (ANCOVA) levels suggested that the TEMF device operates in a therapeutic window at 15 mT. For example, the morning pain level for the patients in the 5 mT group was slightly reduced (5% change), the patients in the 10 mT group the pain relief decrease was 14% and the patients in the 15 mT group achieved the largest reduction (24%). The low observed effect size (difference from placebo) in the 5 mT & 10 mT groups, when coupled with the added degree of within-group variability in the 10 mT group, supported the decision to discontinue the lower EMF dose levels. Therefore, the four study groups were changed to two, the placebo and 15 mT groups.

In summary, the analysis of the biological responses in a cell-free myosin phosphorylation, a chick embryo explant model, normal and inflammatory T lymphocytes, and vascularization and tumor growth in animal tumor models appears to show a beneficial effect at all applied magnetic fields with a maximum effect at 15 mT magnetic flux density. All these results indicate an “amplitude window” response. Pain relief in a double blind clinical study of chronic low back pain also shown to be greatest at 15 mT treatment. The results shown in this paper clearly indicated that a number of biophysical or cellular methods might be useful in selecting appropriate signal parameters which may be of clinical importance.

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THE EFFECTIVENESS OF ELECTROMAGNETIC FIELDS IN THE RECOVERY OF MOTORNEUROPATHY

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The study describes the effectiveness of electromagnetic field (EMF) on the forelimb grip strength recovery and radial nerve structure restoration in mice with motorneuropathy induced by the administration of 0.62% 3,3'-Iminodipropionitrile (IDPN) in drinking water for 9½ weeks. The grip strength measured by a force gauge meter indicated a 47% decline compared to untreated control group. The EMF gradients, close to physiological ranges, could modulate the energy state of nerves *in vivo* thereby restoring structural integrity. The EMF intensities (in a Milligauss to Microgauss range) and frequencies (Hertz) were calculated considering the masses of critical molecules in nerve function and generated an uniform field between two 18" copper wires (Helmholtz configuration) placed 9" apart. The IDPN group that received EMF exposure for 8½ weeks showed a grip strength increase of 87%, which was sustained at 82% without EMF treatment followed up to 27 weeks. Electronmicrographs of nerves from mice after EMF exposure indicated axon remyelination and a condensed state of mitochondria consistent with grip strength recovery. The results support a role of EMF in the regulation of neural activity and provide a novel and non-invasive approach to the management of peripheral neuropathy.

10. INITIATIVE REPORTS

EFFECT OF LOW FREQUENCY ELECTROMAGNETIC FIELD (LF EMF) ON THE SPECIFIC ELECTRICAL CONDUCTIVITY (SEC) AND PH OF DISTILLED WATER (DW)

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Since water is a dominant component of biological systems it serves as a medium where all metabolic processes take place. Therefore, it was suggested that the minor changes in physicochemical properties of water can significantly modify cell functional activity. On the basis of this fact water is suggested as the main target through which the biological effect of LF EMF on cell and organism is realized. At present abundance of data is accumulated on the effect of LF EMF on the physicochemical properties of water. However, limited investigations were performed on the study of this effect in dependence on the frequency. In present work LF EMF (2.5 mT) frequency-dependent effect on water SEC and pH was studied. The SEC of DW was measured using special glass test chamber (1cm in diameter, 5 ml) with two electrodes inside. 1 cm² platinum electrodes, spaced by 0.5cm to each other, were connected with the conductivity gauge allowing to measure SEC at less than 10⁻⁹A, 70 Hz currents. To expose the DW to EMF a sine-wave generator with special coil generating 2.5 mT EMF was used. SEC of DW treated by 4, 10, 15, 20, 50 Hz EMF for 30 minutes was measured. It was shown that SEC of freshly prepared DW (22° C) elevates by 8% during the first 30 minutes, while the further EMF exposure at 4, 10 and 20 Hz frequencies leads to its decrease by 15, 10 and 12% accordingly. 15 and 50 Hz EMF expositions had insignificant effect on the SEC of DW. In the next series of experiments it was revealed that during the first 30 min pH of untreated DW increased by 2.5%, while in the cases of 4, 20 and 50 Hz EMF exposures it decreased by 2, 3 and 4.5% respectively. Insignificant changes of pH (by 0.18%) were observed at 10 and 15Hz EMF treatment. The non-adequate dependence of DW SEC and pH on EMF frequency allows us to suppose that EMF – induced changes of DW SEC are not simply due to the changes in proton concentration in DW. As the effect of EMF on SEC and pH of DW was the most pronounced at 4–20 Hz it is predicted that these EMF frequency “windows” can be more effective from the point of the biological activity.

TEST BIOLOGIC ENTITY FOR EVALUATING THE INFLUENCE OF WEAK ELECTROMAGNETIC RADIATION ON BIOSYSTEMS.

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It is widely known that electromagnetic emissions of hardware adversely affect the human organism, causing various pathologic reactions.

Direct experimentations on human beings always raise ethical aspects, connected with the remote consequences of such experiments. Even now the percentage of children, born entirely healthy is close to zero. Therefore, the use of biologic entities with a short life cycle for the purpose of experimentation and extrapolation of the results of such experiments on human beings attracts growing interest. Human body contains micro biotic communities in the equilibrium state and weak external electromagnetic emissions may shift this equilibrium state so that saprophytic bacterial population becomes aggressive. It should be expected that the symbioses are more sensitive to weak electromagnetic influences than pure cultures.

This work suggests the use of symbiosis of *Tortula* yeast fungus and *Bacterium xylinum* and *Bacterium xylinoides* acetic-acid bacteria as a test biologic entity, sensitive to the emissions of the hardware. Metabolic products of the symbiosis possess certain therapeutic properties. The experiments showed that the selected biologic entity is highly sensitive to the electromagnetic emissions of a monitor, completely ceasing its development and degrading (losing biomass) when placed within 30-60 centimeters from operating monitor.

Test demonstrated certain increase in the speed of development of symbiosis in comparison with the reference sample when “Gamma - 7n” protective devices was placed on the operating monitor. In other experiment no electromagnetic emissions of hardware were affecting the symbiosis, instead the symbiosis was 3 times a week influenced by “Gamma – 7A” activator for 15 minutes. The experiment showed that the symbiosis’ development was stimulated and the speed of biomass growth increased twice in comparison with the reference object.

Thus the work suggests using undemanding and sensitive for electromagnetic emissions biologic entity - symbiosis of *Tortula* yeast fungus and *Bacterium xylinum* and *Bacterium xylinoides* acetic-acid bacteria for evaluation of weak electromagnetic emissions. “Gamma – 7n” has a distinctive shielding effect, while “Gamma – 7A” has its own biologic potency.

CHANGES OF SPECTRAL AND CHROMATOGRAPHIC CHARACTERISTICS OF WATER SOLUTIONS OF NATURAL BIOLOGICAL ACTIVE COMPOUNDS UNDER ACTION OF CONCENTRATOR ELECTROMAGNETIC FIELDS

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Creation of ampli-modifier of turbulent electromagnetic fields proves to be one of the most promising developments in the field of energy-information processes' management in natural environment and human body [1,2]. Developed device enables transformation of thin background energy structures into determined bio-energetic flow of turbulent nature with magnetic, electrical, thermal, and gravitational components.

Mechanism of these energy flow caused effects has not been fully revealed, but it already clear, that traces of its impact have been determined in studied systems on cellular and molecular levels.

Studies of samples conducted by Erisman's Federal Centre of Hygiene have already proved magnetic field concentrator's (MFC) impact on drinking water quality improvement[3]. Nevertheless, many results happen to be of narrative character. More definite and repeatedly achieved results are required for systematic theoretical modeling in this field of studies.

Present paper cover selected data, obtained in course of special program implementation devoted to research and proof-testing of effects caused by MFC treatment of model liquid system such as water solutions of phenolic and poliphenolic natural compounds.

Chemical analysis of MFC treated and further γ -irradiated (0.2 Mrad) liquid samples, was based on UV-VIS spectrophotometry and HPLC methods. Achieved results enable 1) registering MFC impact on quercitin and alcylohydroxybenzene water solutions; 2) detecting "memory" effect external electromagnetic fields influence in model systems.; 3) stating that level of self-organization of studied solutions determine value of MFC's effect and its character.

RESEARCH OF ENERGY-INFORMATION EFFECT IN MODEL SYSTEMS

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Researched influence low intensity extremely high-frequency (EHF) EMF of an environment for the second time retranslated by the generator an Aura-009, designed in SRI BINAR, in a narrow spectrum EHF in a range of resonant frequencies of cellular structures. The effect by the generator essentially promoted a spontaneous O₂-metabolism (chemiluminescence, CL) neutrophils (Nph) of a blood of the man at 15–20 minutes of exposure and reduced CL, inhibited by toxic doses of erythromycin inducing apoptosis of cells, inhibited development of apoptosis in Nph, induced UV-exposure. The effect of the generator strengthened production of IL-1 by phagocytes in vitro and RBTL, induced KonA, not influencing on synthesis of IL-2 in lymphocytes (Lph); considerably raised adhesive power of leucocytes of a blood in vitro, being metabolically dependent and mirroring function activity of cells. The 25-minute exposure of a whole blood of the man with an Aura-009 caused the expressed changes phenotype of cells reduced percent Lph and monocytes (Mn) with expression of activation markers – receptors of a transferrin, antigens apoptosis Fas/Apo-1, Nph with expression Fas/Apo-1 increased. A boosted contents Lph and Nph with expression of molecules of an adhesion Mac-1 simultaneously impinged, percent of K- cells (Nph and Mn with expression of a Fc_γ-receptor) accrued. These changes testify to cell-like modulation under influence of an Aura-009 and probable rise killing of potencies of phagocytes, that proves to be true by an amplification of them CL. It is important, that the activation CL and adhesive power of cells happened at exposure to the generator at 0° C, when their metabolism is completely inhibited, – its activation was taped at the subsequent warming of cells. It testifies that on cells the information effect is carried out which is saved further irrespective of temperature and in a particular degree from time. The generator did not change activity of 4th of enzymes of serum of the man, conformation IgA, IgM, IgG and collagen.

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