THE IMPACT OF ENERGETIC ENGINEERING ON HEALTH AND ENVIRONMENT

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Rezumat. *Această lucrare se referă la impactul tehnologiei energetice asupra sănătății și mediului. Aici sunt descrise rețele electrice și emisii de poluări în atmosferă, politica de mediu, este prezentată structura raportului de mediu Transelectrica, generarea în câmp electromagnetic și influența câmpurilor electromagnetice în bio-organisme.*

Abstract. *This paper handles the impact of energetic engineering on health and environment. Here are described the electrical networks and the emissions of pollutants in the atmosphere, the environment policy, it is presented the structure of Transelectrica environment report, the generation of electromagnetic field and the influence of electromagnetic fields on bio-organisms.*

Keywords: energetic engineering, electromagnetic field, electrical networks, environment policy, consumption

1. Electrical networks and emissions of pollutants in the atmosphere

The negative impact of overhead electrical lines one the surrounding environment is of type:

- *physical*, through possession of the territory, clearing of vegetation;
- *electromagnetic*, though effects of the electric and magnetic field on beings and systems of telephony, radio, TV etc.:
- *visual*, through effects on the landscape;
- *mechanical*, through possible danger of collision with the flight devices, fall hazard at road, railway, water crossings, etc. and fire hazard during accidental contact with objects or dry vegetation;
- *sound-like*, through noises caused by operation, vibration of network's elements or "corona" phenomenon;
- *chemical*, through generation of ozone and nitrogen oxide because of the "corona" phenomenon.

The positive impact of electrical lines on the social and economic environment is present through:

- *Creation of employment* during the entire service life of lines and electrical stations (design, operation, maintenance);

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- *Ensure of electric power traffic* from producers to distributors/ consumers, the benefic effects of electric power utilization in all human activities being well-know.

Design, execution and proper operation of electrical networks lead to reduction of own technological consumptions [CPT] that determine the following ecological effects:

- *Reduction of emissions of pollutants* (in water, soil, air) associated to the entire technological flow (extraction of fuel, transport, preparation, burn, storage of slag/ ash, including greenhouse gas with major contribution of climate changes);
- *Preservation of natural resources* in the spirit of “long-term development” notion.

Electrical networks allow the access of consumers to “green” power plants: hydroelectric, solar and overhead power stations.

The relative value of own technological consumption [CPT] within electrical networks, expressed in percentages [%], stands as a statistic indicator that characterizes the operation of an electro-energetical system.

The negative impact on the surrounding environment is proportional to the power loss obtained through:

- observance of development programs (investments);
- improvement of operating conditions of the installations and equipment through dispatcher control;
- reduction of commercial losses within networks (inventory, computation procedures, systems of measurement and count of active power and quadergy).

2. Environment policy

The environment policy depends on analysis of progress made at:
- structure of the electro-energetical field;
- types of property and privatization;
- regulations of electro-energetical system.

Political issues make reference to:
- political issues of regulation;
- choice of fuel and investments;
- safety of supply;
- policy of the surrounding environment;
- energetical efficiency;

- tariffs;
- new system of risk allocation.

The structure of electro-energetical field [SEE] runs through a period of dramatic changes. Among them, the following should be known:
- definitions from SEE;
- historical analysis of SEE structure;
- integration of SEE structure at vertical level;
- integration of SEE structure at horizontal level;
- restructuration of SEE;
- cooperation conventions in SEE.

The types of property and privatization are:
- mainly public property systems;
- mix systems;
- mainly private systems;
- related relations through national and international services;
- engine factors for privatization through corporation and privatization.

The SEE regulation implies independency, transparency, impartiality and means:
- economic regulation;
- regulation of state-owned services (social contract, direct regulation);
- regulation of investor-owned services (detailed, structured regulation and minimized regulation).

The political regulation issues refer to:
- public monopoles (corporations, privatization);
- private services (private non-competitive services, competitive supply, access to transportation);
- tight competition.

The choice of fuel and investments depends on:
- decision factors in investments (costs, technical performances, prices and benefits, temporary value of money, fuel – technology analysis);
- factors for fuel selection;
- transport and distribution;
- expressed preferences.

The certainty of electric energy supply implies knowledge of:
- problems' nature (time scales, network and related problems);
- structural and regulation aspects (integrated systems, with no competition, uncorrelated systems with and without competition).

The policy of environment in the field of electric power engineering means to determine:

- the impact of the electric power engineering on the environment;
- regulation of the environment (atmosphere pollutants, solid waste, quality of waters, laws concerning location of power plants);
- government action means (through direct regulation instruments, economic instruments, through information and consultancy);
- effects of the property type and of the structure (determining the limits and sanctions, options on fuel and technology, political means, commercial implications of standards on competitive markets);
- consequences of electric power engineering impact on the environment.

Energetical efficiency depends on:

- explanations for involving the consumer;
- interaction of motivation and structure of power engineering domain (energetical efficiency based on political actions, regulation actions, on business);
- effect of changes in the power engineering domain (competition, structure, property type).

The rates applied to electric energy refer to:

- cost depreciation in time;
- rates applied to marginal costs;
- market rates (for countries and energetical interconnections);
- rates' structures;
- other aspects (independent generation, self-generation, uncorrelated prices, etc.).

The new system concerning risk allocation in the domain of power engineering refers to:

- definition of risks (business risk; financial risk; physical risk; risk and income: who takes-over the risk);
- traditional risks on the market of electric power (integrated monopole of the state and private property);
- new developments and their effect on the risk (lack of correlation with no modification of the property type, reorganization of public private services, effect of competitive factors, role of contracts when determining the risks, role of laws when reorganizing the risks).

In Romania, the following should be defined:

- main themes of energetical policy;
- current situation (demand of electric power, production/ prognosis of electric power production capacities, transport and distribution systems, trade);
- industrial structure (main partners, independent producers of electric power);

- regulations (monopoly laws / supply commitments, environment, mechanism of price fixing, energetical efficiency);
- prices, taxes and commercial aspects (structures of rates, distortions of fuel supply, commercial barriers, subsidies).

The Romanian Stock Exchange for transaction of electric power has liaisons with the following European stock exchanges:

- European Energy Exchange [**EEX**]:	http://www.eex.de
- Intercontinental Exchange [**ICE**]:	http://www.theice.com
- Energy Exchange Austria [**EXAA**]:	http://www.exaa.at
- Nord Pool Spot [**AS**]:	http://www.nordpool.no
- Spanish Power Exchange [**OMEL**]:	http://www.omel.es
- PowerNext France:	http://www.powernext.fr
- Towarowa Gielda Energii Poland:	http://www.polpx.pl
- Operator of Electric Power Market in Romania:	http://www.oper.ro

Through the European Climate Change Program – ECCP, the European Union provides a frame for development of political initiatives, via the environment laws.

In Romania, there are:

- National Authority of Energetical Regulation	http://www.anre.ro
- National Authority of Natural Gas Regulation	http://www.anrgn.ro
- National Authority for Mineral Resources	http://www.namr.ro
- National Committee concerning Control of Nuclear Activities	http://www.cncan.ro
- Autonomous Administration concerning Nuclear Activities	http://www.raan.ro
- PowerNext France:	http://www.powernext.fr
- Towarowa Gielda Energii Poland:	http://www.polpx.pl
- Operator of Electric Power Market in Romania:	http://www.oper.ro
- S.C. Termoelectrica S.A.	http://www.termoelectrica.ro
- ELCEN [Electrocentrale]	http://www.elcen.ro
- Nuclearelectrica	http://www.nuclearelectrica.ro
- Hidroelectrica S.A.	http://www.hidroelectrica.ro
- Transelectrica S.A.	http://www.transelectrica.ro
- Termoelectrica S.A.	http://www.termoelectrica.ro
- Electrica S.A.	http://www.electrica.ro
- Teletrans	http://www.teletrans.ro
- S.C. SMART S.A.	http://www.smart.sa.ro

3. Transelectrica environment report

The report is structured as follows:

- Profile C.N. Transelectrica S.A.;
- Environment Management System and its organization;
- Policy, environment objectives and targets;
- Environment aspects with major impact of the transport electrical network;
- Actions concerning environment protection;
- Research-Development;
- Training;
- Communication;
- Expenses on environment protection;
- Conformity to legal requirements;
- Glossary.

4. Generation of electromagnetic field

According to studies prepared by the Polytechnics University from Bucharest - Faculty of Energetics, Desk of Power Engineering that calculated the distribution of electric and magnetic low-frequency field nearby the overhead lines of 220 kV and 400 kV, in Romania the intensity of the electric field is reduced as the distance increases so that at a distance of approximate 25-30 m away from the line axis, the field intensity is equal to zero.

Because of the poor electric supply of the overhead power lines, the measurements carried out by ICEMENERG in the protection and safety areas of electric transport network installations present some levels of electric and magnetic fields that are much below the values calculated and below the maximum allowed limits in the case of population, values which were decided through Order MSF no. 1007 / December 13, 2002. Therefore, for the range of frequency de 50 Hz:

- the intensity of the electric fields is E = 5 kV / m;
- the induction of magnetic field is H = 0,08 A / m;
- the magnetic induction or magnetic flux density is B = 0,1 mT.

The work team WG 37-36 of the Study Committee C3 CIGRE has determined the social and environment constrains on the development of electric networks:

- social and environment issues;
- physical factors;
- biological factors;
- cultural heritage;
- social and community factors;
- laws and approvals;

- ecological business administration;
- glossary.

5. Influence of electromagnetic fields on bio-organisms

The electromagnetic spectrum begins with the electrostatic and magneto-static fields, crosses the electric and magnetic fields of 50 Hz, the radio and light electromagnetic waves and goes up to the ionizing radiations γ. [figure 1]

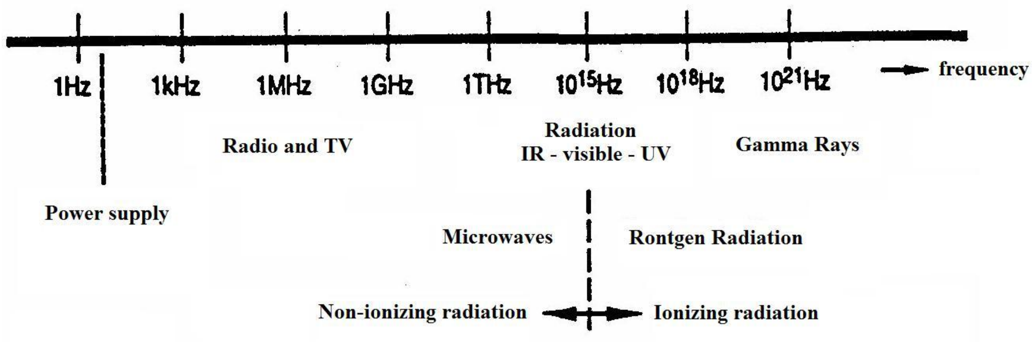

Fig. 1. Electromagnetic spectrum.

Depending on intensity and frequency, the electromagnetic fields and waves prove to be extremely *useful* or extremely harmful to bio-organisms.

In the range of high frequencies that begins with *ultraviolet radiation*, the power of electromagnetic waves given by formula:

$$W = h \cdot f \qquad (1)$$

(*W* – power; *h* – constant of Planck, *f* - frequency) is sufficiently high as to separate the electrons present in the electronic shell of atoms and as such to ionize them causing chemical modifications or modifications of another type.

In the case of human beings, as the frequency increases, these modifications start with the so much desired *skin tan* until to *skin cancer* and even some various forms of more sever types of cancer. The various forms of electromagnetic waves occurrence in this range of energies are basically considered as *ionized radiations*.

Starting with the range of frequency of *visible light* without which our life on Earth would not be possible, we reach to *infrared radiation*, respective thermal radiation, and the range of microwaves.

The action of *microwaves* on bio-organisms is determined by the force exerted on loaded particles

$$F = Q(E + v \times B) \qquad (2)$$

Under the action of this force, the electrons and ions (atoms or ionized molecules) oscillate in the alternating field of microwaves and dipoles oscillate around their position of equilibrium. Through collisions, the kinetic energy of oscillation transmitted to particles is communicated to other particles and has as result the increase of their *average kinetic energy*. This energy application is macroscopically shown through *temperature increase* of the irradiated matter, phenomenon with a wide range of utilization in the case of microwave ovens.

Along the forces exerted by the electromagnetic fields on electric loads and dipoles, according to relation (2), there are forces with analogous action on *magnetic dipoles*, respective on ammeter ring currents occurred as a consequence (*spin nuclear body section radiography*). The lack of magnetic dipoles with major dipolar moment obstructs the finding of a macroscopic thermal effect.

The density of thermal energy produced by variable electric field is directly proportional to the frequency, but at smaller frequencies it drops quite a lot. On the basis of this frequency dependency and lack of a proper correlation, in the past there was reached the conclusion that field intensities usually encountered in *electric power engineering systems*, respective in *communication systems* are not dangerous to human beings.

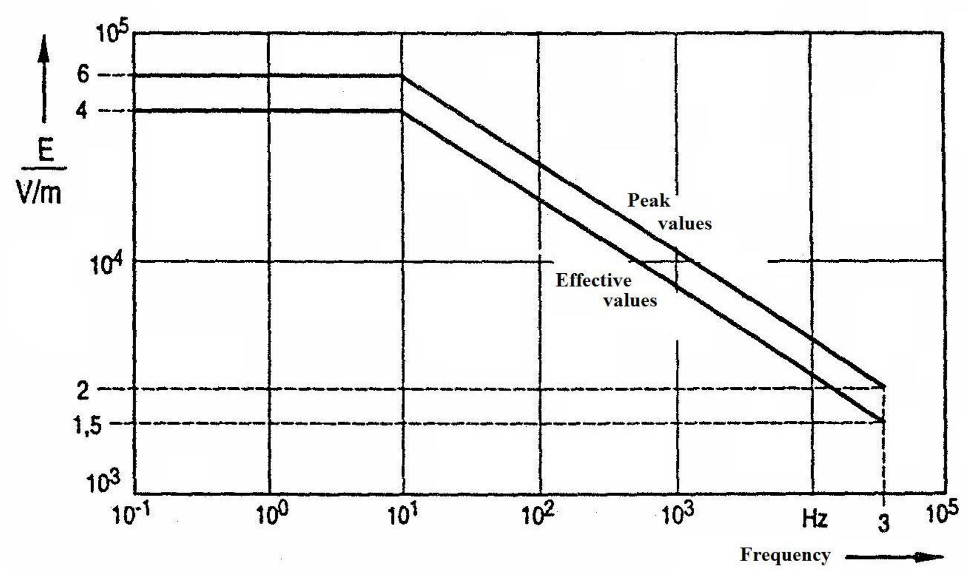

Fig. 2. Real and top limit values ***on intensity of the low-frequency electric field*** that guarantee protection of the staff during direct exposure.

During short-term tests performed until present inside the laboratory, no direct dangerous influences were noticed. The effects like *high-frequency burns, flimmers,* phenomena that are long known, occur only at field intensities with much bigger values. These types of studies are of concern to people who by profession are exposed to high field intensities, like the maintenance staff for: high-voltage installations, radio and TV emission installations, industrial high-frequency installations etc.

The few results obtained during the short-term researches conducted in laboratories do not ascertain for sure that a *long-term exposure* to smaller field intensities cannot lead to effects that until now we are not aware of. Since thermal effects of small field intensities, especially of low frequency disappear it means that we should take into account the so-called *biological effects*.

Thereby papers were published on debates concerning modifications of the behavior, disorders of the immune system, headaches, fatigue and even high probability of cancer [1].

If they really exist, such interrelations may be established only through *long-term epidemiological analyses*, which experimentally were impeccable executed. The conclusions available now on the harmful effects could not be entirely confirmed through control tests so the issue continues to be highly controversial. Based on the experience on the danger present in case of long exposure of people to high field intensities, big surprises are unlikely to occur. A final clarification on this issue continues to remain a goal.

Besides the analysis of *harmful effects*, the systematic research of some *benefic effects* that until now were unknown is of high interest. For example, the positive effects of electromagnetic fields in the healing of fractures, in electro-diathermy, etc. give more reasons to hope.

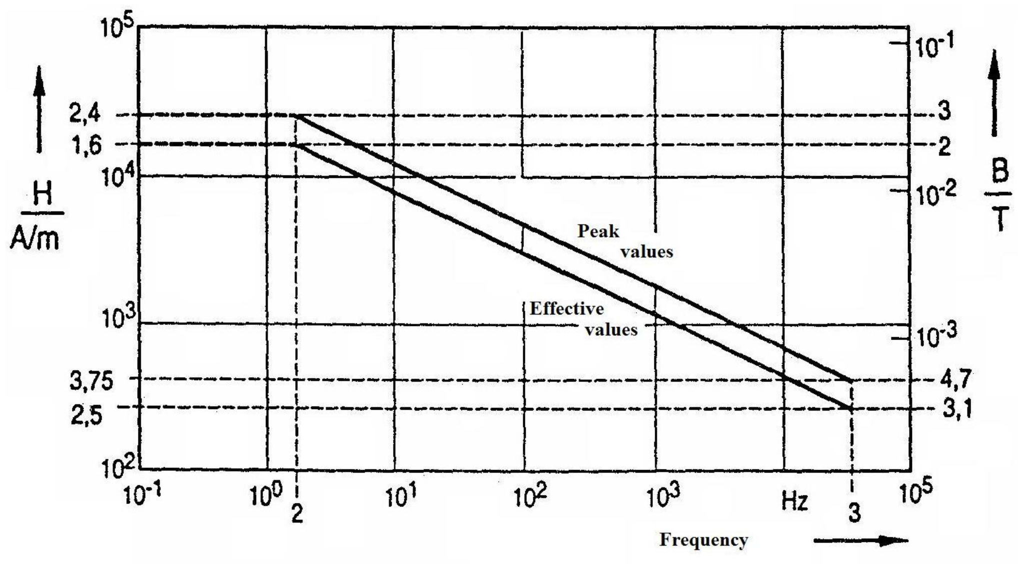

Fig. 3: Real and top limit values ***on intensity of the low-frequency magnetic field*** that guarantee protection of the staff during direct exposure.

In the following, we will make a brief reference to limit allowable values of fields, which in various countries can be extremely different. These differences are based less on the dissimilar knowledge on the harm caused by electromagnetic fields as they are based on the different definition of what is understood by limit allowable value. Thus, the limit value taken into account in the former Soviet Union and in other east-European countries refers to the level of field intensity below which no biologic effects can appear, while western countries consider the value of field intensity, over which proven harmful effects appear (it is a value that via a safety coefficient may be defined as maximum limit allowable value).

The debates on the real level of danger of limit values for various types of fields and frequencies are taking place on international level. The usable reference values are for example [2], [3], [4], [5] the limit values valid in Germany according to VDE 0848.

In figures 2 and 3 there are presented the limit values for the range of low frequencies between 0 Hz and 30 kHz.

Through *direct exposure* it is meant the direct action of fields on people. Limit values do not consider the existence of eventual heart stimulators, implants, etc. that could trigger to a higher sensibility of those people, situations when the limit values should be smaller (provisions now being under elaboration).

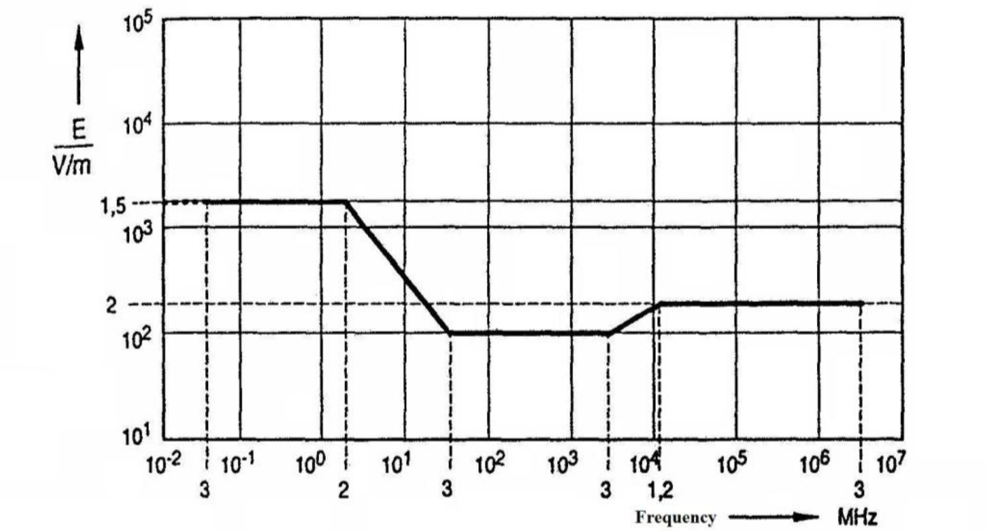

Fig. 4. Real limit values for the high-frequency equivalent electric field (VDE 0848).

The intensity of equivalent field in the related figures corresponds to a vector of field intensity obtained from summation of field vector components measured on the three directions x, y, z without considering the lagging. For short action durations that last less than 6 minutes, there can be accepted higher limit values that may be determined subject that the maximum value of energy remains constant (see VDE 0848 [7]).

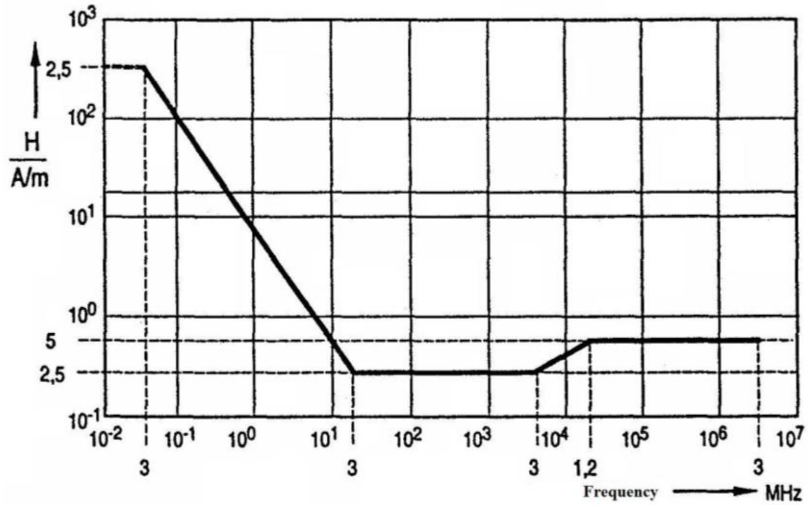

Fig. 5. Real limit values for the equivalent high-frequency magnetic field (VDE 0848).

Finally, in figures 4, 5 and 6 there are presented the limit values for electric, magnetic and electromagnetic fields for the frequency range 10 kHz - 3000 GHz and an action length over 6 minutes.

The above-mentioned explanations and indicated limit values serve only as introductory to this problem.

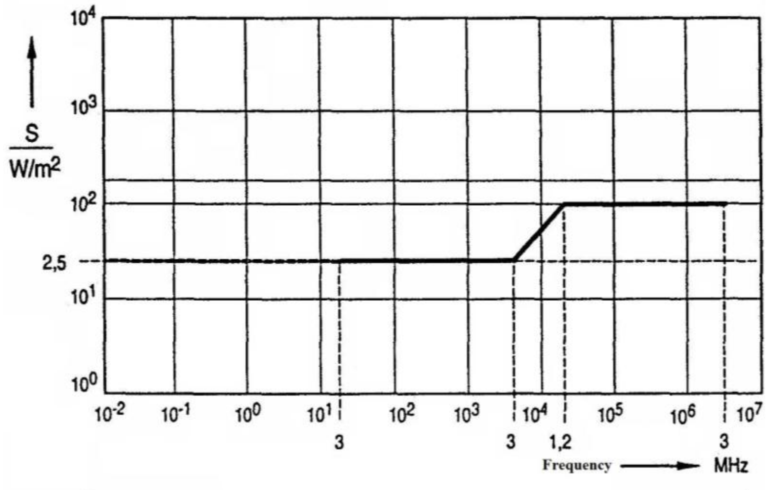

Fig. 6. Real limit values for the density of high-frequency energy (vector Poynting, VDE 0848).

In the case of concrete situations or problems concerning exact interpretation of the given limit values, it is compulsory to analyze the provisions in force and the bibliography[8–19].

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