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Romania Compliance with the EU Requirements in Environmental Impact of HV Installations

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Abstract - Environmental protection keeps on being one of the main concerns of our company, together with the economic efficiency and providing of high quality energy services. *The general goal* of the environmental policy consists in improving the environmental management system and mitigating the power units' negative impact in compliance with the regulations in force. *The specific goal* accommodates the general goal to substations and electric lines, having as short and medium term target the compliance with the European requirements.

National Power Grid Company is facing hard problem regarding EMF – pollution management. The risk assessment regarding HV Equipment of our company involves very precise measurements and the awareness campaign of all the involved parts: owner (power system industry), residential population, operating personal, the National Regulatory Authority a.s.o. the project will support the environmental policy of the company, which requires a strong monitoring EMF pollution; as well as the implementation of an environmental management system according to ISO 14001. The main goal of the project is to improve the life quality of the operating personal and to diminish the environmental impact of the owner's HV installations (TRANSELECTRICA, ELECTRICA, HIDROELECTRICA Companies).

As a result, more and more companies organise environmental studies and audits in order to evaluate their environmental performance. But such activities are not sufficient in themselves to provide the certainty that the performances comply to the regulation in force, and to the environment policy requirements. In order to become effective, these studies and audits have to be organised within a structured management, based on modern systems of global pollutants monitoring.

Key-Words: environmental impact, monitoring system, magnetic field, cumulative exposure, biological risk

1 Introduction

All power system units, especially the ones pertaining to power systems are lately preoccupied to reach real environmental performances, so they strain to control the environmental impact of their own activities, products and services by closely following the environmental policy and objectives set forth.

These activities correspond to the ever stricter regulation and to the development of the economic policies and similar measures liable to stimulate environmental protection and the interest of the implied parties on environmental issues, sustainable development included. International standards on environmental management aim at providing the interested parties the fundamental elements of an environmental management system, elements that are specific to other management requirements as well and are expected to facilitate the companies to reach their environmental and economic objectives.

The success of these activities depends on the company commitment at each level and responsibility.

A similar system allows one company to organise and evaluate the efficiency of the environmental policy procedures, to obtain compliance to this policy, and to demonstrate these qualities to other interested parties.

Since almost three decades stronger and stronger public concerns on potential negative effects of electric and magnetic fields exposures are internationally expressed The concern is focused on low-level, relatively low-frequency (power frequency, 50 Hz) fields and their impact on the overall health state of the professional and of the residential personnel in the close neighbourhood of HV and MV electric networks.

It is to be stressed from the every beginning that the voltage domain specific to the electric power transmission is richly documented on such effects, the complementary domain of lower voltages specific to power distribution being relatively neglected. One possible explanation for their lower interest could be the opinion that lower voltages produce lower intensity fields, without considering that in these cases the clearances are also smaller and the currents are higher.

The vicinity of the electric power distribution lines – smaller clearances, together with high phase currents in normal operation conditions – increases the interest in the magnetic component of the line generated fields.

2 Goals and steps

The main objectives of compliance with the EU requirements in environmental impact of HV installations and the activities to reach them are:

a. Organizing a public awareness campaign regarding the environmental impact on human health of the high voltage installations (HVI):

- Assessment of environmental impact of the HVI in our company:
- Organizing public debates, conferences, workshops
- Conducting a promotion public campaign (posters, WEB page a.s.o.)
- Promoting the achieved results in co-operation with media, authorities, other potential companies having similar problems, national ecologist organizations;

b. Setting up studies on electromagnetic field (EMF) impact, devoted to:

- Sources evaluation;
- International assessment of the human health;
- International exposure guidelines;
- Summary of the present situation in HV substations of TRANSELECTRICA – STB Company
- Estimating technological transfer opportunities for the partners;

c. Market impact estimation

- EMF Monitoring system cost estimation (optimistic and pessimistic approach)
- Profit estimation; indirect benefits estimation for “electrical” occupational problems
- Improving the specific parameters for the quality of life

To meet the environmental policy goal we proceeded and shall still proceed according at last to the following principles:

- To take measures for pollution prevention and for the continuous improvement of environmental protection within all our *high voltage substations and overhead lines.*
- To harmonise the environmental goals with the size of the negative impact of various activities developed in our company
- To inform, control and take care that the environmental goals be accomplished through the implementation of an highly efficient environmental management system
- To promote an open public dialogue by providing information on the environmental issues coming out from the monitoring system of our installations.

3 Partners and contributions

Both Romanian partners: **The National Grid**, represented by national companies: TRANSELECTRICA, ELECTRICA and HIDROELECTRICA and **University "POLITEHNICA" of Bucharest,** as research unit, developed in the last years a monitoring system for the effects of the HV and MV substation magnetic field, having a long partnership for research in EMF area (about 20 years). Some national complex projects were developed and tested over a three-year period. The units involved are working together not only for solving the problems underlined above, but also for many other purposes regarding the improvement of HV transport system in Romania and the fulfilment of the requirements for the energy market.

The **NTUA partner** involvement and support consists in providing not only information, training and consultancy for the basis establishment of an efficient EMF monitoring system, but also to share

experience in measurement techniques and to support measurement technological transfer opportunities.

Description of the partnership outcomes:
The effects on human health, conducted in relation to EMF generated by HVI remain inconclusive until systematic long-term studies will be carried out. So that, in order to clarify the problem for owner's HVI, a monitoring system is to be established

- Improving the knowledge on this subject both for the electricity companies and residential people.
- Sharing experience and getting training in measurement and monitoring techniques within EU related units.
- Creating new individual and communitarian mentalities, related to environment protection against HV EMF pollution
- Creating the basis for national guidelines in order to restrict the human exposure to EMF
- Complying to European Community recommendations

There is no consensus of the international bodies on the health EMF effects. The evidence for such problems is often contradictory. However, these fields are widespread and there are still a lot of questions to answer. Further research, laboratory studies and high performance measurement systems are needed in Romania to clarify the issues.

4 National projects in HV environmental impact

4.1 Monitoring of the magnetic field impact on HV substation personnel

The common projects developed,, having S.C. "Electrica" - S.A, . and "Transelectrica S.A" as beneficiary, represented by Deva distribution branch and Civil Protection Institute of Deva an Transelectrica branches in several parts of the country, set forth as its main target the **monitoring of the magnetic field impact,** a relatively less studied objective, but for which the correct evaluation of the real stresses is more important, considering the high frequency of environmental incidence of the electric power distribution lines on the professional and residential personnel, as well.

Thus, the much higher number of distribution lines and the much denser populated areas they cross, they have to be considered. So, not only the number of potential impact sources is considerably higher (as compared to the case of transmission lines), but the number of the subjects liable to be affected is also considerably increased in this case.

The present state of the measurement techniques allows for a more accurate analysis of the distribution of the electric and magnetic field generated by the HV installations and equipment, in order to determine the impact both on the human being and the environment. Unfortunately, the Romanian measurement equipment is hardly sufficient for covering the area to be monitorized.

So that, ***the progresses are coming out slowly, especially for the identification of all the factors involved in the electromagnetic pollution of the HV Equipment.*** The documents describing the impact of HV installations, particularly the ones having rated voltages equal to or less than 100 kV, have been issued in order to check their compliance to the EU standards on environmental protection within electric power supply sector.

4.2 Operational Personnel Medical Evaluation Data

Within the programme, the employees active in substations of "Electrica" - S.A. (Bucharest and Deva branches) were medically assessed. The selected substations have technical and operational similitude.

The medical evaluation was focused on:

- clinical examination, the results of which shall be inscribed within personal forms;
- data acquisition on mortality, considering previous activity and results of the medical laboratory tests of each subject, data that could be subsequently used within a correlation analysis;
- filling in of a detailed form regarding professional antecedents of each subject (employment duration, allocated jobs, professional or non-professional exposures to different noxious agents).

The data base includes all information describing the daily cycle of the subjects (awakening/sleep) and workplace and house lighting (during day and night), which strongly affect the subjects' homeostasis (daily hormonal rhythm).

The medical tests include:

- electrocardiography stand-still tests, using a Marquette type device and graph analysis;

- laboratory tests (blood tests and urine tests) for a complete hemoleucograme and biochemical constants identification (e.g. creatinine).

A special protocol will be designed for urine test, in order to allow for the dosimetry of the hormonal levels for **corthysol and 6-hydroximelatonin sulphate**.

For each subject, the proposed procedure will allow for comparing the results specific to similar time intervals. This comparison is important, since the variability of hormonal cycle of the same subject is considerably small; comparing hormonal levels of different subjects, that is liable to introduce false results caused by the large domain of the specific physiologic values of the group, could thus be avoided.

The first stage of the medical investigation can not lead to a final conclusion regarding the effect of the work environment on the health state of the personnel. It has to be stressed that the analysis of the hemoleucogrames for the test group shows that 30% of the subjects present a pathological state of lymphopenie (a reduced number of lymphocytes).

Such results are encountered for subjects working for more than 10 years in the same location and aged 31 to 55 years, and none of them presents a pathology that could motivate that state.

We appreciate that in the present stage issuing conclusions prior to completing the hormonal study and tests for the whole group is premature. There is one aspect that have to be pointed out: the personnel working within electric power distribution substations has to be monitorized for a long period (10 to 20 years) in order to appreciate all the influence the EMF exposure.

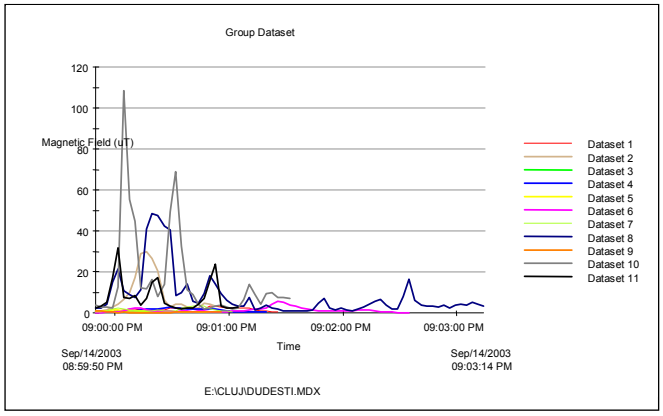

Fig. 1 – General distribution of the magnetic induction within Dudesti substation
Maximum value: 6 kV coupler bay, approx. 108 μT

4.3 Magnetic Field Experimental Results

Measuring the magnetic induction ***B*** was carried out searching for the module of this vector quantity and storing the results for different points at ground level, along a predefined path.

During the experimental test the paths have been selected along energised bus-bar systems and along primary circuits of the heavily loaded line bays. Experimental data have also been collected along paths near or around power (auto) transformers within the analysed substation.

The data have been stored in the memory of the measuring device and subsequently processed using the field data software package EMCALC 2000.

The results mentioned in the *Test certificate – Magnetic field* are graphically presented in Figure 1. The loads for the scanned primary circuit are presented in Table 1.

Table 1

Dudesti substation	Primary circuit	Load current, A
110 kV	LEA FCME	100
	LEA Solex	120
	LEA Bucuresti Sud	90
	T2 110 kV	68
6 kV	Cupler	300
	T2	1080

Note: Substation primary circuits have been loaded at about half of their rated load, for both voltage levels. The field values have been measured for the loads in the above table, and they are proportional with the specific circuit load.

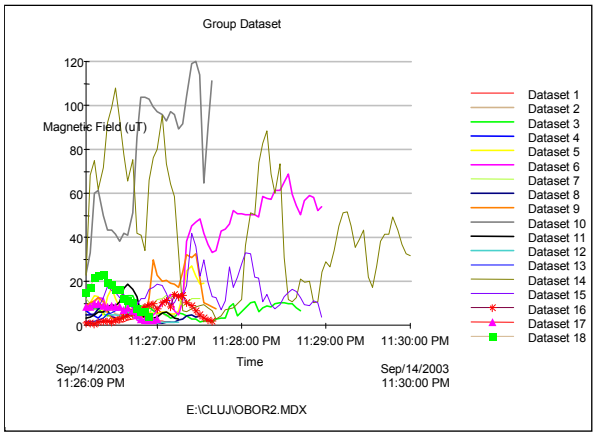

Fig. 2– General distribution of the magnetic induction within Obor substation
Maximum value: approx. 120 μT

Table 2

Obor substation	Primary circuit	Load current, A
110 kV	LES Bucuresti Nord	145 (max. 600)
	LES Fundeni 1	140
	LES Fundeni 2	260
	Transformer T5, 110 kV	115
20 kV	Transformer T2, 20 kV	10

Note: Some of the primary circuits have been loaded at a quarter of their rated load. The magnetic induction values have been measured with the loads mentioned in the above table and they are proportional to the load current of the specific circuit.

As for the 400 kV substation of Cernavoda NPP, the value measured shows much less value of the magnetic field, as in Fig. 3.

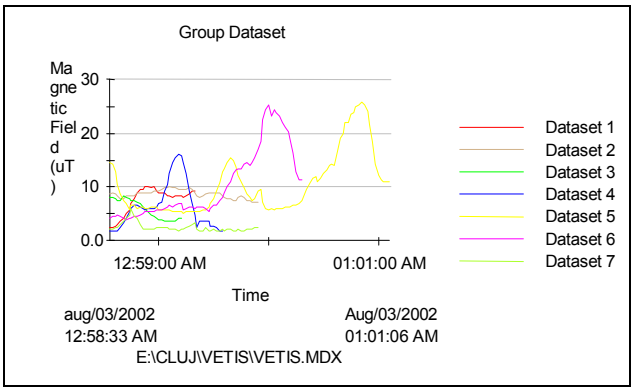

Fig. 3 – General distribution of the magnetic induction within Cernavodă NPP 400 kV substation
Maximum value: coupler bay, approx. 24 μT

According to the experimental results under such conditions show that at rated load the field within the 6 kV bay can be higher than **200μT**.

Remarks:

- Measured values of the magnetic field are lover than the 0.5 mT limit mentioned by the regulation in force. Reduced values have been identified for 110 kV circuits, while **much higher values have been identified for the MV circuits**.
- The five substations analysed in this first stage of the project, as well as the overhead line owned by Constanta branch are environmentally friendly (low values for the two electromagnetic field components).
- The two Bucharest branch substations (one of the of the indoor type), as well as the transformer substation located in the basement of the Opera Centre building are characterised by particularly high magnetic field values generated by the MV circuits.
- During the experimental study, the circuits have been loaded at 1/3…1/2 of their capacities, so that under specific operating conditions the magnetic field values could by **2…3 times higher**.
- For the indoor substations - where the operating staff and especially the maintenance staff could be exposed for 1 to 6 hours a day - a detailed and accurate study regarding the **annual exposure duration** and the **cumulative exposure**, as main factors of biological risk. is necessary.

Table 3 containing the maximum field values within S.C. "Electrica" – S. A. substations

Sub-station No.	Substation name	Voltage levels	$\|E\|$, kV/m	$\|B\|$, μT	Notes Electric/Magnetic field
01	Navodari	110 kV/10 kV	**4,66**	**11,91**	MOP, door open / Transformer T1, MT
02	Eforie	110 kV/20 kV/10 kV	**4,10**	**5,01**	DRV / Substation 20 kV
03	Dudesti	110 kV/6 kV	**4,95**	**108,32**	DRV / Coupler, Substation 6 kV
04	Obor	110 kV/20 kV/10 kV	**4,48**	**119,84**	Bus-bar disconnector, 110 kV / Bus-bar, bay T7, 6, 5, MT
05	LEA	110 kV, double circuit	**2,05**	**2,79**	Under lateral phase / maximum sag
06	Opera Centre	10 kV/0,4 kV	**1,06**	**71,52**	Indoor substation/Bus-bar, bay T2

5 Conclusions

The preliminary results show that high magnetic field values are encountered at locations where the personnel can be present for relatively long periods. The scope of the first stage in progress is to provide data necessary to develop an **efficient monitoring system** (evaluation and mitigation) for the negative impact of the HV and MV installations within densely populated areas regarding the **quality of life** and the possible **dimi-nishing of the biological risk**.

The potential impact of the electromagnetic field on the health state of the living structures is still a problem of public debate and the final solution is still to come. Although it can be stated that it is particularly necessary to grant the cohabitation of the general public and the present power T&D systems and the electric power utilities (large and small consumers).

The last five years it had been performed measurements of electric field intensity and magnetic field induction in about 40 high voltage substations in Romania, in order to identify and to index the risk hazards for operating personal health. The results have been correlated to specific medical investigations and tests. The aim of the study is to contribute in establishing new limits for human exposure to electromagnetic field and to obtain a new methodology for EMF biological risk assessment.

When the risk assessment is used in support of health and safety decisions, two elements should be quoted: the effect on the major risk and the number of people who would benefit.

The exposure data used in Romania by risk assessors should use information to reflect the hazards and medical consequences currently applicable and the methodology should be revised whenever the circumstances change in the workplace.

It seems that other potential beneficiary will join the research, extending the evaluation area to the HPP personnel: HIDROELECTRICA S.A., which manages 334 hydropower plants, located in 32 counties. The management of the hydropower plants is carried out by 12 subsidiaries.

The main activities of HIDROELECTRICA are power generation and ancillary services through the operation of hydropower plants while observing high standards of quality, safety and environmental protection. The environment programs developed under the slogan "Investing in the future" aim at extending the cooperation with academic institutions, youth organizations, and civil society for the promotion of an ecological education and responsibility toward the environment.

Since Romania seeks to meet the efficiency and quality requirements imposed by EU and to become a part of a real economic and social competition, major structural changes are necessary. In Romania, no economic sector and no company (be it large or small, producing goods or services) could avoid the obligation to provide the domestic and the international markets with good quality products.

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