ENVIRONMENTAL IMPACT OF HIGH VOLTAGE SUBSTATIONS

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ABSTRACT

The first Romanian methodology for simultaneous environmental and human risk evaluation in case of HV installations within substations pertaining to nuclear power stations, based on EU regulation is now applicable in Cernavodă substation.

High voltage substations are zones where the environmental impact is focused on electromagnetic field that's causes particular effects in living tissues (human being included). That is the reason why is necessary to identify the potential risk sources, the asses including the way to correct them and to dissimulate the results to the staff and the operational personal.

1 ENVIRONMENTAL IMPACT

All 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.

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.

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 depend on the company commitment at each level and responsibility. A similar system allows one company to organize 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 neighborhood of HV 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 was 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 vecinity 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.

As compared to the electric field, the magnetic field is the subject of a considerably lower number of references, while both components have been relatively seldom studied within the range of distribution voltages. The common project, 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 personnel. Thus, the much higher number of distribution lines and the professional personnel could be considered. So, not only the number of potential impact sources is considerably higher, but the number of the subjects liable to be affected is also considerably increased in this case.

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

TEST CERTFICATE - MAGNETIC FIELD	
Beneficiary	S.C. "Transelectrica" - S.A. , Bucharest branch
Objective	**CERNAVODA Substation**
Voltage levels	400 kV
Measuring date	August 2002
Measured quantities	Magnetic induction (μT): **B** (resultant magnitude)
Measuring system	EMDEX II
Manufacturer	Enertech Consultants, EPRI, California, U.S.A.
Weather conditions	Sunshine

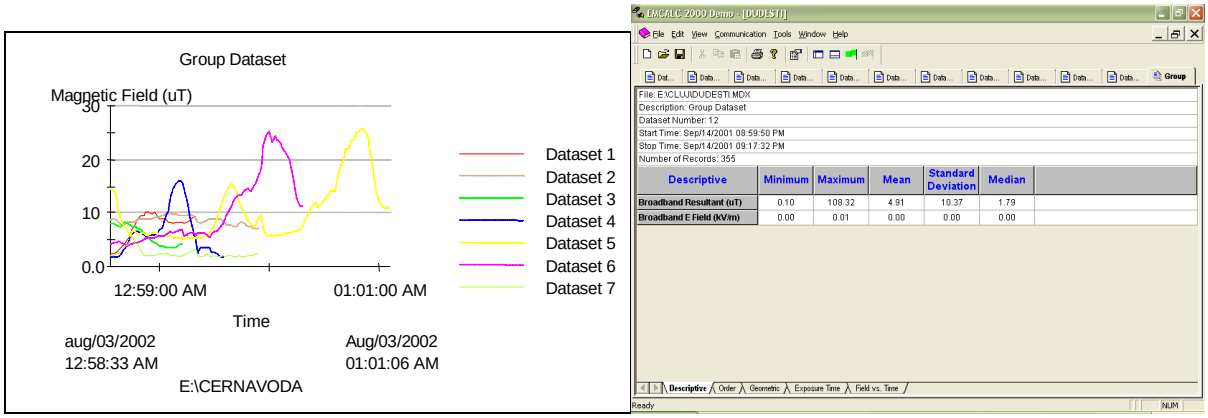

Figure 1 General distribution of the magnetic induction within Cernavodă substation Maximum value: 400 kV coupler bar, approx. 24 μT

The results mentioned in the *Test certificate - Magnetic field* are graphically presented in Figure1.

Note: Substation primary circuits have been loaded at about half of their rated load. The field values are proportional with the specific circuit load. According to the experimental results under such conditions show that at rated load the field within the 400 kV bay can be higher than 150 μT.

– Measured values of the magnetic field are lover than the 0.5 μT limit mentioned by the regulation in force. Reduced values have been identified for 400 kV circuits, while much higher values have been identified for the MV circuits.

– For this area, where the operating staff and especially the maintenance staff could be exposed for 1 to 6 hours a day, a detailed and accurate study is necessary regarding the annual exposure duration and the cumulative exposure, as main factors of biological risk.

3 OPERATIONAL PERSONNEL MEDICAL EVALUATION DATA

Within the programme, the employees active in substations pertaining to S.C. "Transelectrica" - S.A. shall be medically assessed. The selected substations have technical and operational similitude.

The medical evaluation shall be 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).

All these data are useful during analyzes to identify and correct different misleading factors, as well as for granting the homogeneity of the test group. To this aim, data shall be collected regarding possible contamination with noxious substances, non-professional random exposures to other electromagnetic fields (mobile phones or dwelling place being located close to electric networks or radio antennae). The data base shall include 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 test shall include:

- electrocardiography stand-still tests, using a Marquette type device and graph analysis;
- laboratory tests (blood tests and urine tests) for a complete hemolecograme and biochemical constants identification (e.g. creatinine)

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

Since all subjects are active persons working for 12 hours followed by a 24-hour rest and considering their daily cycle specific to this hormones, the influence of the professional exposure to electric and magnetic fields could only be traced in case the urine is collected non stop for three days for each subject. Each test could allow for a sinusoidal graphical representation of the cumulative effects of the different simultaneous factors. 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 working within electric power distribution substations. There is one aspect that has to be stressed: the analysis of the homoleucogrames for the test group shows that 30% of the subjects present o 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.

4 CONCLUSION

The results of the research described in this paper are expected to have a clear applicability within risk management field:

1. checking a project applicability;
2. verifying the conformity of an installation (electric equipment), according to the regulation in force;
3. estimating exclusive clearances;
4. preparing emergency plans;
5. formulating restrictions regarding use of equipment;

6. selecting the methods for maintenance and risk control;
7. identifying risk sources;
8. testing the procedures that will form the basis of future regulation;
9. determining the opportunity of changes within risk control system.

The project should also consider the implication of the human factor in the operation of electric power installations within nuclear power plants. Considering the importance of this subject, the most appropriate modes to select qualified personnel for the operation of power installations become one of the top priorities for many outstanding national and international entities.

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 installations within densely populated areas regarding the quality of life and the possible diminishing 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).

A major subject is the mitigation of the living structures exposure to the action of the electromagnetic field. This objective is technically attainable, but the implied cost is still to be assessed. This cost has to be analyzed by comparing the cost of diminishing the electromagnetic pollution of the human (professional and residential) environment with the cost of diminishing the atmospheric pollution or the cost of improving the environment sanitary condition, for instance. When neglected, these aspects are surely more noxious to human life than the potential, still unclear, effects of the electromagnetic fields. Monitoring the level of the low-frequency electromagnetic radiation's remains a main objective to be solved by the power engineers. In order to reach it, they need experimental and computing resources to allow for the precise of the real stresses caused by the electromagnetic field around their networks, so that when the due regulation will be in force stipulating the field limits that could identify the necessary mitigation actions.

Since Romania seeks to meet the efficiency and competitively 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 obligatorily to provide the domestic and the international markets with good quality products.

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