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REGULATIONS ON THE ENVIRONMENTAL IMPACT OF POWER PLANTS

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ABSTRACT

The energy sector, through the conversion of primary energy resources, has important direct or indirect effects on the air, soil and subsoil at local, regional or global level.
The purpose of the work is to determine the degree of pollution resulting from the burning from power plants and to analyze the environmental and public health impact.

KEYWORDS: primary energy, burning, pollution, environmental, power plant

1. THE ENVIRONMENTAL IMPACT OF THERMAL POWER PLANTS

Environmental protection includes all actions carried out by specialists in the fields of engineering, chemistry, physics, biology, economics, legislation to ensure the conservation of natural resources and the protection of the quality of the environment.

Romania is a signatory to international environmental regulations, including: The Convention on Transboundary atmosphere pollution (Geneva 1979), the Convention on Climate change (Rio de Janeiro 1992), the Convention on the Protection of the Ozone Layer (London 1990).

The energy sector, through the conversion of primary energy resources, has important direct or indirect effects on the air, soil and subsoil at local, regional or global level.

The contribution of the energy sector to total pollutant emissions in Romania in 2015 was overall 40%, and separately for emissions of 78% of nitrogen oxides, 68% of dust emissions and 44% of carbon dioxide.

The table 1 gives an overview of the environmental impact of the combustion of different forms of fuels or other sources of primary energy used in power plants.

Table 1 Environmental impact of the energy industry

Primary source of energy	*Main impact*
Charcoal	- contamination of groundwater -soil disturbance, land use change and long-term ecosystem destruction -emissions of SO2, NOx, PM with air quality implications -metal powders -increase the acidity of the water
Oil and gas	-pollution of the sea and the coasts -change of soil, forest degradation, increase in lake water acidity due to - emissions of sulfur oxides and nitrogen -contamination of groundwater -the impact of gases emitted on the increase of the greenhouse effect

Hydro	-land destruction, land use change, sedimentation change -the destruction of ecosystems and the reduction of species diversity in flora and fauna -population displacement
Nuclear	-pollution of surface and groundwater by mining -change of land use and destruction of the ecosystem -the potential for radioactive contamination of land and sea water
Renewable	-contamination of water and ecosystem -change of land use and ecosystem - noise due to operation of the units

The environmental impact of energy-related activities differs according to the transformation stage and the type of primary energy. The greatest impact is that of burning fossil fuels, and among them coal has the most negative consequences in terms of emissions of noxes into the atmosphere and soil pollution.

The actual conversion phase of primary energy into other forms of energy is characterized by a particular intensity of environmental effects. This is the particular stage to be taken on. Nuclear power plants are closest to the concept of environmentally clean power plant, because they are characterized by the total absence of CO2, PM, SO2, NOx emissions, but they represent a particularly high potential hazard for the biosphere, by the radioactive pollution they can cause.

In general, a polluting substance (noxa) is any substance resulting from chemical, physical and biological processes, which are spread throughout the environment, harmful to living organisms, material goods, works of art and the landscape.

The pollutant is therefore a solid, liquid, gaseous or energy substance (electromagnetic radiation, ionized, thermal, noise or vibration) which, when introduced into the environment, changes the balance of its constituents and living organisms and damages material property**.**

In terms of pollution, the negative environmental impact of thermal power plants is mainly caused by the following types of emissions:

-emissions to air;
-emissions to waste water,
-emissions of solid residues;
-noise emissions;
-thermal emissions (heating of cooling water due to its use in installations)
-other emissions such as visual impact.

Emissions contribute in a differentiated way to the environmental impact.

Emissions of NOx and SO2, for example, may dissolve in rain water forming acid rain. In the long term these emissions are decisive in lowering soil pH, favoring mineral wool and heavy metals, and in degradation of soil and groundwater quality.

Similarly, direct liquid emissions into soil and groundwater change soil quality. The poor disposal of waste will also lead – together with the rain water entering through this waste – to the dissolution of pollutants, affecting the quality of the soil and groundwater. Gaseous, liquid and solid emissions are thus linked to each other. In order to make the best possible in reducing the environmental impact, emissions should be considered as a whole.

There is no doubt that gaseous emissions into the atmosphere are the most important and dangerous. Therefore, the focus of restrictions and their strict application will be mainly on these emissions.

Liquid emissions are an important factor in the protection of surface water, especially groundwater. They affect not only biological life in rivers and lakes, but also the capacity to self-clean water with an impact on drinking water sources.

Solid emissions are the products of thermal power plants that can be divided into two classes: (1) substances produced in large quantities which are low toxic, and (2) substances produced in small quantities but which are more dangerous to the environment.

In the first category, we can mention ash, and in the second, waste oils or old batteries. Both substances may pollute or endanger large areas of land, surface water or drinking water.

Reducing the visual impact is very important for the power plant's image in relation to its neighbors and potential shareholders, but it is difficult to detail through specific regulations. However, the visual impact is part of an environmental assessment and is mentioned in the corresponding recommendations.

Noise emissions affect workers in the turbine room, in boilers or in coal mills more. Noise emissions are also mentioned in various regulations and must be respected.

2. THE EFFECTS OF GASEOUS POLLUTANTS

2.1. The source of Sulfur emissions

Sulfur oxides in the form of SO2 dioxide and SO3 trioxide form as a result of the combustion of fuel oil and solid fuels containing sulfur. In the combustion of natural and artificial gases the formation of sulfur oxides can take place to a very small extent if H_2S hydrogen sulphide and mercaptan are present. By burning, complex sulfur combinations are transformed into simpler ones, which at high temperature and excess air conditions pass into oxides and primarily SO2.

Hydrogen sulfide and elemental sulfur are also oxidized to SO_2. Only a small part of the sulfur is oxidized to SO_3.the sulfur dioxide is stable up to 2127^0C.

Consequently, the SO_2 and SO_3 conversion shall start at high temperatures (approximately 2000^0C) and continue until the flue-gases are released into the atmosphere, the following steps shall be taken:

- conversion of SO_2 to high temperatures by means of atomic oxygen and activated carbon dioxide;
- the SO_2 conversion due to the catalytic action of the fine solid particles of Fe_2O_3. This conversion occurs at temperatures below 800^0C, has the maximum speed around temperatures of 550-600^0C and depends on the excess oxygen concentration;
- conversion of SO_2 to SO_3 and H_2SO_4 as determined by the presence of nitrogen oxides, when the temperature of the gases falls below 300^0C. This conversion becomes maximum around the acid dew temperature.

2.1.1. The effects of SO_2

Sulfur dioxide is in the form of colorless, highly irritant gas. At normal temperature and in the absence of moisture, sulfur dioxide is a relative, highly reactive and highly stable gas.

The poisoning with sulfur dioxide occurs immediately after an interval of only a few hours. It is characterized by respiratory disorders, painful thoracic pressure, coughing, lipotomies. Chronic poisoning starts with irritating, respiratory and ocular symptoms, dental lesions, skin lesions and respiratory disorders. The main toxic action is therefore that of a particularly high respiratory tract irritant at high concentrations, with sulfur dioxide directly affecting the respiratory system. It is also noted its harmful action on bone marrow and spleen. High concentrations produce acute bronchitis.

In addition to the symptoms mentioned, sulfur dioxide causes eye irritation accompanied by lacrimation and garlic. Dissolution of sulfur dioxide in the saliva may result in gastris. Splashing with sulfur dioxide causes frostbite due to its strong cooling action (-50C).

The phytotoxic effects of sulfur dioxide are strongly influenced by the ability of the tissues to convert it into relatively non-toxic forms. Depending on the amount of sulfur dioxide per unit time to which the plant is exposed, biochemical and physiological effects such as degradation of chlorophyll, reduction of photosynthesis, increase of respiratory rate occur. These effects translate into necrosis, reduction of plant growth, increased susceptibility to pathogens and excessive climatic conditions.

2.1.2. Limit values, margins of tolerance for concentrations of pollutants in sulfur dioxide-emissions

The limit values (table 2) are expressed in µg/m3 and are determined according to OM 592/2012. The volume shall be expressed in standard conditions (temperature 293K and pressure 101,3 kPa).

Table 2 Limit values

	Period of mediation	*Limit value*
1. Limit value for the protection of human health	1h	350 µg/m^3 not to be exceeded more than 24 times in a calendar year
2. Limit value for the protection of human health	24h	125 µg/m^3 not to be exceeded more than 3 times in 365 days
3. Limit value for the protection of ecosystems	365 days	20 µg/m^3

2.2. The source of NO_x emissions

In the combustion process of fuels, together with the other components known in the combustion calculation and nitrogen oxides are produced. At the outlet of the chimney, the flue-gases contain 95% of nitrogen oxides as nitrogen monoxide and only 5% as nitrogen dioxide.

Nitrogen monoxide is rapidly converted into NO_2 in the process of spreading the flue gases to oxygen-containing air and even ozone.

The main sources of these noxes, which are particularly harmful to people and the

environment, are:

-the molecular nitrogen contained in the combustion air which, under high temperature conditions in the flame, reacts with oxygen in the air, forming so-called thermal nitrogen monoxide (thermal NO mechanism). Thermal No genes, in the flame core, occur at the same time as the combustion of most fuel;

-nitrogen contained in the fuel, in the form of compounds which break down in the combustion process to form the so-called nitrogen monoxide in the fuel (NO fuel mechanism);

-the molecular nitrogen contained in the combustion air, which combines with free hydrocarbon radars, which exist only in the oxidation zone, forming the so-called early nitrogen monoxide (NO precocious mechanism).

When analyzing the genesis of nitrogen oxides, the main factors influencing the formation of more or less oxides are:

- high temperature and excess oxygen in the burning zone,
- fuel quality (expressed as nitrogen and volatile content, calorific value the temperature at which volatile release takes place, the rate at which this occurs);
- construction of burners, organization of combustion.

2.2.1. NO_x effects

Nitrogen compounds constantly contribute to the pollution of the atmosphere, nitrogen dioxide NO_2 is one of the most dangerous pollutants.

Besides the fact that NO2 is toxic as such at certain concentrations, it contributes directly to the formation of photochemical-smog, a complex product composed of various chemical compounds and having as a physical substrate aerosol particle (solid or liquid suspensions in the atmosphere).

The formation of the pitch is primarily the production of internal combustion engines - residues of unburned hydrocarbons, lead, bromine, boron, etc. Under the influence of solar rays, especially ultraviolet (UV), secondary and tertiary reactions occur from which other substances, such as ozone, PAN, acrolein, formaldehyde, are generated, peroxyacetyl nitrate, etc... Of these PAN and ozone have particularly strong toxic effects.

Nitrogen dioxide under the action of UV rays reacts and gives nitrogen oxide and atomic oxygen. Part of it combines with nitrogen oxide regenerating NO_2, which maintains NO_2 in the atmosphere. Another part of atomic oxygen combines with O_2 and gives the ozone - very reactive and highly oxidizing. The ozone reacts with the residue of hydrocarbons which then combine with PAN. PAN has strong toxic effects on plants, even at low concentrations producing necrosis of leaf tissues, inhibits photosynthesis.

2.2.2. Limit values, margins of tolerance for concentrations of pollutants in nitrogen oxides

The limit values (table 3) are expressed in µg/m3 and are determined according to OM 592/2012. The volume shall be expressed in standard conditions (temperature 293K and pressure 101,3 kPa).

Table 3 Limit values

	Period of mediation	*Limit value*
1. Limit value for the protection of human health	1h	200 µg/m^3 not to be exceeded more than 18 times in a calendar year
2. Limit value for the protection of human health	24h	40 µg/m^3
3. Limit value for the protection of ecosystems	365 days	30 µg/m^3

2.3. The source of carbon oxides

Carbon dioxide in flue-gases from steam boilers is an inherent result of the complete burning of fossil fuels. The concentration of CO_2 in the flue gas is even higher as the ratio of carbon to hydrogen content of the fuel is higher. Carbon monoxide occurs in the flue-gases in general when liquid or gaseous hydrocarbons are burned completely.

The main causes of CO developing are:

- imperfect mixing of fuel with oxygen;
- insufficient oxygen in some areas of combustion (substation combustion),
- residence time of the fuel particle in the combustion chamber too short.

2.3.1. Effects of carbon oxides

It is a colorless gas without smell. It is formed in industrial enterprises following the incomplete combustion of carbon-containing materials. It is often found in cast iron and steel foundries, in exhaust gases when testing engines, etc.. Toxic action is manifested at a concentration of 0,06 mg/L air. Carbon oxide enters the body through the airway.

In the blood, it combines with hemoglobin

and forms a stable carboxyhemoglobin (COHb) compound. This compound does not transport oxygen to the tissues and, as a result, anoxemia occurs. In this case, the central nervous system and cardiovascular system are affected to the greatest extent.

By blocking an amount of hemoglobin, CO produces hypoxia, causing immediate (sometimes acute) effects and long-lasting (chronic) effects. Immediate effects are due to a decrease in the amount of oxygen brought to the tissues and depend on the percentage of carboxyhemoglobin. At higher concentrations, hypoxia affects the brain and the heart, organs that are very sensitive to lower oxygen concentration.

Acute effects are related to disturbances caused by hypoxia or anoxia and depend on the percentage of carboxyhemoglobin (COHb) formed.

Blood-based COHb concentrations of 0,5%-0,8% are characteristic for persons with no CO exposure. Up to 2% of COHb in the blood no physiological or pathological changes were reported. Between 2-10% COHb in blood the first signs of hypoxia appear, in most cases, with no subjective manifestations. However, these levels of COHb concentrations caused brain circulation disorders in people who have consumed alcohol, sedatives.

At 10-20% COHb in blood, in addition to the phenomena described, headache is shown, obvious reduction in physical and intellectual performance, dyspnea and tachycardia.

At a concentration of 20-40% COHb acute intoxications with intense headache occur: Vertigo, nausea, sensory disorders; at more than 40% of COHb in blood, man loses consciousness and at 60% death can occurs in a short time.

Chronic poisoning occurs in people exposed to relatively high carbon oxide concentrations for a long time and is characterized by an astheno-vegetative syndrome. In moderate but repeated concentrations, carbon oxide can cause a number of side effects, such as cardiovascular damage.

In CO poisoning prevention, mechanization and automation of technological processes are of great importance, especially when charging and discharging furnaces, and the permanent operation of general and local ventilation. Automatic systems are available to indicate when the maximum allowable concentration has been exceeded, especially when testing engines.

2.3.2. Limit values, margins of tolerance for concentrations of pollutants in carbon monoxide-oxide

The limit values (table 4) are expressed in µg/m3 and are determined according to OM 592/2012. The volume shall be expressed in standard conditions (temperature 293K and pressure 101,3 kPa).

Table 4 Limit values

	Period of mediation	*Limit value*
Limit value for the protection of human health	Maximum daily 8 hours average value	10 µg/m^3

3. THE EFFECTS OF PARTICULATE MATTER

Non-toxic solid particles up to 20 microns in diameter are included in this category. Of these, those with micronical and submicronical diameters penetrate through the respiratory tract into the lungs where they are deposited. When the amount inhaled over a time period exceeds the amount that can be naturally eliminated, lung dysfunctions occur, starting with a decrease in the respiratory capacity and the exchange surface of blood gases. These phenomena are conducive to the installation or timing of cardiovascular problems.

3.1. Limit values for particulate matter (PM_{10})

The limit values (table 5) are expressed in µg/m3 and are determined according TO OM 592/2012.

Table 5 Limit values

	Period of mediation	*Limit value*
1. Daily limit value for the protection of human health	24h	50 µg/m^3 PM_{10} not to be exceeded more than 7 times in 365 days
2. Annual limit value for the protection of human health	365 days	20 µg/m^3 PM_{10}

4. EFFECTS OF WATER POLLUTION BY HYDROCARBONS

Most thermal power plants also use oil-fuel, thanks to the advantageous thermal properties (high combustion heat, ignition, automation and storage facility). Unfortunately, oil fuel households also result in blends of oil and water, which cannot be evacuated directly to the sewage system. These mixtures may arise from washing transport tanks, draining tanks, washing loading-unloading ramps or from accidental discharges. Due to the unpredictability with water, most hydrocarbons rise to the surface of the water and begin to move in the dominant directions. Volatile compounds evaporate quickly if they remain in contact with air. On the surface of the water, the oil forms an oily film that stops the air from being distributed, thus acting directly, mechanically, on flora and fauna. The coating of organisms with a thick film of oil that prevents their breathing, i.e. the access of atmospheric air to the aquatic environment, almost totally blocks the chlorophylana uptake and breathing of organisms. From the point of view of the drinking of surface water and groundwater, the particularly severe influence of the mixture with petroleum products is mentioned. Thus, even dilutions 1:1 000 000 between drinking water and oil-contaminated water, the resulting water is not good for drinking.

Another form of water pollution is thermal pollution. Thus, the water used in the production of electricity, in particular that used to cool down condensers, by priming the heat-charged waste water, must not exceed 350C in the natural receiver.

5. CONCLUSIONS

The paper analyses the environmental impact of energy-related activities according to the transformation stage and the type of primary energy into the power plants.

The environmental impact of energy-related activities differs according to the transformation stage and the type of primary energy. The greatest impact is that of burning fossil fuels, and among them coal has the most negative consequences in terms of emissions of noxes into the atmosphere and soil pollution.

The conclusion is that the greatest impact is that of burning fossil fuels, and among them coal has the most negative consequences in terms of emissions of noxes into the atmosphere and soil pollution.

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