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The Evaluation Of Performances Of Installations By Power Plants From Romania Concerning Professional Risks

ALICE RADUCANU [1], AURICA SUVERGEL[1], ANGELA STANCA[1], AURELIA MEGHEA[2]
[1]Department : Energy Environment Center
Institute for Energy Research And Development
Address : Energeticienilor, No.8 Bld., Bucharest 3
ROMANIA
alicer@icemenerg.ro, http://www.icemenerg.ro

[2]Department : The National Consultancy Center for Environmental Protection
University "POLITEHNICA" of Bucharest
Address : Polizu no.1, Bucharest 1
ROMANIA
a_meghea@chim.upb.ro, http://www.upb.ro

Abstract : A number of workplaces where the employees work under noxes environment exist within the thermal power plants. The infliction of the working environment has more or less detrimental effect upon the personnel exposed depending on the existing noxes toxicity, the concentration, exposure duration, and constitution of the subjects exposed.
At present, a number of specific measures have been taken in the power generation sector in order to limit or eliminate the noxes, with a view to prevent the employees to fall ill, however these measures gave not the expected efficiency.
Identification of the places with a high noxes level and the preparing of the technical-organisational solutions for the improvement of the physical and chemical noxes exhaustion and elimination, including also the impact of their application financial costs represent all factors of major importance for lining up the occupational noxes levels with the national and European standards.
This paper describes the evaluation of a real situation by help of the modern methodologies for the identification and monitoring of the physical and chemical noxes from two Romanian thermal power plants, the analysis of the health condition for the employees exposed to such physical and chemical noxes and it establishes, in the end, the risks of the occupational exposure.
Further on, the main technical solutions for the diminishing of the occupational noxes at the workplaces from the thermal power plants are described. These solutions consist of various types of phono-isolating and phono-absorbing cabins intended for the reduction of the noise level; ventilation systems of the honeycomb type, modern niches made of corrosion resistant materials for the reduction of the chemical noxes, use of the non-asbestos sealing materials.
Through the implementation of the technical solutions for the attenuation of the occupational noxes a major desiderata is provided for lining up with the Regulations of the European Community concerning the increase of the life quality in the workplaces from the energy industry.

Key-Word : modern technical solutions, diminish, occupational noxes, workplaces

1. Introduction

Numerous places where the employees work in noxious environment still exist within the thermal power plants from Romania. The noxious environment can be more or less injurious to the personnel exposed depending on the concentration, exposure duration and constitution or the subjects exposed. Until the present moment a number of specific measures have been established in order to reduce or remove noxes with a view to prevent the employees to fall ill ; nevertheless the results have not always been the expected ones. In order to provide the corresponding conditions for the labour safety and health in the energy sector, it is necessary

to apply, on the one side, some local organisational measures which lead to the operation of the existing equipment under conditions of tightness while maintaining the cleanliness at the workplace and to take, on the other side, some technical measures by introducing new installations or apparata to reduce noxes under the maximum acceptable value, maintain the cleanliness at the working place or keep away the personnel from the noxious environment.

2. Problem Formulation

The objective of this paper is to find out some modern technical solutions, which diminish as much as reasonably possible the chemical and physical noxes and establish some measures aimed at reducing the exposure of the power sector personnel to the noxious environment. The examination of the workplaces is intended to establish the level of the noxes and take some measures for converting the risks into non-risks or smaller risks through the cognition of the noxious factors (and the risks due to them) existing in the environment of the workplaces and establish the measure specific for the collective and individual protection and, last but not the least, the cognition of the measures aimed at reducing, preventing, eliminating the occupational risks. The paper is a novelty due to the approach of a new fundamental & applied research topics (reduce the impact on the environment and improve life conditions through the implementation of the non-polluting technologies) in the workplace health and safety domain and through the replacement of the old, heavy and deficient technologies from the point of view of the operation, technology, control and efficiency with modern technologies (de-dusting installations) used abroad currently. When examining an industrial enterprise from the toxicological point of view, the workplaces supposed to be included within special conditions should be identified while the determination of the occupational noxes should be made only following a Study of the Technological Process. It refers to the detailed cognition of the raw materials and materials, finished products and intermediary products, equipment and technological process, operation of the respective equipment and tasks of the persons exposed. On the basis of the Technological Process Study noxes to be determined will be fixed taking into account the fact that they can come from any chemical substance participating in the investigated process. Analysis of the noxes exposed employee health condition is essential for the accurate establishing of the measures aimed at preventing the personnel exposure to occupational noxes.

Special attention should be focused on the chemical substances that occur randomly because of the impurities existing in the various reagents added in the substances that appear as wastes because the toxicity of these products is sometimes higher than the one of the substances they derive from. At the identification of the noxes there will be taken into account the physical-chemical properties, such as; the state of aggregation (vapours, gas or suspended matters, aerosols or dust), boiling point, vapour pressure, solubility because the cognition of these parameters determine the working methods to be used. In case several noxes are simultaneously present in the same workplace, after the identification of such noxes, a classification and hierarchy of them will be made while taking into account their cumulated and synergetic action upon the human organism, establishing thus the level of risk it has on the personnel.

2.1. Working Condition

The phrase "working condition" includes four factors:

- Physiological factors (correlated with the professional tasks and labour safety);
- Hygienic factors (pertaining to the working ambient):
  - Physical factors (noise, microclimate);
  - Chemical factors (toxic substances from the technological process);
  - Physical -chemical factors (occupational powders);
  - Biologic factors (viruses, microbes, parasites);
- Ergonomic factors (depending upon the man – machine relationship);
- Psychosocial factors (depending on the inter-human relationships in a collective).

2.2. Occupational noxes

Professional noxes represent those factors of the labour conditions that influence negatively the health condition of the employees' organism (which favour or determine the state of illness) or working capacity.

Taking into account the appurtenance criterion, the 4 component factors of the notion "working condition", the professional noxes pertaining to the working environment are classified, in their turn, as

physical, chemical, physical-chemical, biological noxes.

2.3. Hygienic factors

The hygienic factors are the physical, chemical, physical-chemical, biological factors.

In a technological process, depending on the workplace where they work at, the workers are exposed to a plurality of noxes that can be grouped as:

-Chemical noxes: monoxide de carbon, sulphur dioxide, nitrogen oxides, hydrochloric acid – vapours, sulphuric acid, ammonia, toluene, sodium hydroxide, hydrazine, ethylic ether, trichlorethylene, mineral oil, aliphatic hydrocarbons;

-Physical noxes: noise, microclimate;

-Physical-chemical noxes: powders.

2.3.1. The physical factors belonging to the working environment are represented by :

- noise
- microclimate

2.3.1.1. Occupational noise represents a complex of sounds of various intensity and height, with different rhythmic or non-rhythmic characteristics, which are produced continuously or discontinuously by the working means, workshops transportation means, human voice during the professional activity. The maximal level of the noise, at the workplace, necessitating the normal neuropsychical and psycho-sensorial solicitations of the attention is 87 dB(a) NAEC per workweek. To obtain the weighted global level, expressed as dB(A) for the workplaces where the level of the noise is constant, the measurement of the acoustic level of the sound is made with an audiometer in certain determining (in the "hearing" zone: at 5-20 cm from the pavilion of the ear, around the source of noise, concentrically) in certain moments of the determination (in dynamics). It represents the main etiological factor for the occupational deafness/low hearing.

Occupational deafness represents a hearing deficit at the conversational frequencies (arithmetic mean of the values at 500-1000-2000 Hz), with more than 25 dB included following the application of the presbycusis correction of the perception type, generally of the perception, bilateral and symmetric types of occupational aetiology.

Occupational hypoacusis represents a definite hearing deficit at 400Hz frequency, with more than 30 dB included after the presbycusis correction of the perception type, generally of the perception, bilateral and symmetric type without interest in the conversational frequencies, of professional aetiology.

2.3.1.2. Industrial microclimate represents a set of physical factors of the air in a delimited space that exercises its action on the body thermal regulation function. The workplace microclimate is determined by temperature, humidity and motion speed of the air, being strongly affected by the temperatures of the surfaces and caloric radiation released in the working area. Instruments needed for measurement are the: psihro-meter (for air temperature and humidity) cata-thermometer (for air current speed), glob-thermometer (for caloric radiation). Determination is made in certain points (where a large number of employees are gathered) at a 0.5-1m distance from the floor, at the level of the windows with operational/non-operational fan); at certain times (in the dynamics, in the peak moments of the technological process).

2.3.2. Chemical Factors which belong to the workplace ambient are represented by : carbon monoxide, nitrogen oxides, hydrochloric acid, sulphuric acid, ammonia, toluene, hydrazine, sodium hydroxide, ethylic ether, trichloretylene, mineral oil, aliphatic hydrocarbons, etc.

2.3.3. Physical-Chemical Factors, which belong to the workplace ambient, are represented by powders.

The powders are aerosols of inert particles (system of solid particles that are dispersed in a gaseous media – atmospheric air – capable to remain suspended in this media a longer time and have the large surface related to the volume.

Forming Mechanism:

- Mechanical fragmentation of a solid body;
- Oxidation of the vapours which result from the volatilisation of a solid body via heating/combustion, in contact with the air and sometimes resulting from the evaporate consecutive sublimate.

The properties of the powder are determined by:

- Diameter of the particles;
- Concentration of the powders in the air of the workplace;
- Specific surface of the particles;
- Mineralogical chemical composition of the inhaled particles;
- Electric loading, shape, solubility, hardness of the particles.

Powders determine the occurrence of the following diseases:

- pneumoconiosis;
- obstructive chronic bronco-pneumonia;
- respiratory duct irritating syndrome;

- fume fever (metal powder).

Acceptable concentrations:

- powders with or without contents of free crystalline SiO_2:

- total powders : - 4 mg/cm air for powders with contents of free crystalline SiO_2

-10 mg/cm air for powders without contents of free crystalline SiO_2

3. Material, method, results

Starting from the activity and technological process taking place in two thermal power plants:

Progresul-Bucharest CHP – 4 x 50 MW, liquid fuel-fired

Rovinari CHP – 4 x 330 MW, solid fuel-fired

The following determinations were made with the above mentioned power plants:

3.1. Investigation of the physical, chemical, physical-chemical factors belonging to the workplace environment:

3.1.1. Physical Factors

A) Noise

B) Microclimate

3.1.2. Chemical, physical-chemical factors: CO, NO_x, O_3, HCl, toluene, ammonia, hydrazine, NaOH, mineral oil, trichoretylene, H_2SO_4, ethylic, total powders.

3.1.1. Physical Factors

A) Noise

Investigations were made at the worker's workplace in the normal position of working in the sonorous source action range. Global level was measured by the help of Bruel & Kjaer integrator sound-meter of 2238 type.

Calibration of the sound-meter was made with the piston-phone of 4220 type.

Acoustic pressure level was measured on the A weighing circuit and the slow time constant.

Example of noise measurements: Turbine Section & fuel oil-fired Boiler Section from Bucharest Progresul power plant.

Workplace		NAEC/S dB(A)	Max. Acceptable Limit dB(A)	Exceeding MAL dB(A)
Turbine Section	level 0	85	87	-
	level 6 TA 3	84	87	-
	District-Heating Electric Driven Pumps	82	87	-
Fuel oil-fired boilers	level 20	92	87	-
	level 40	91	87	-
	level 41	96	87	-
	level 13	83	87	-
	pumps – stage I	76	87	-

From the Table above there result that the maxim acceptable limit (MAL) of 87 dB(A)NAEC/S is exceeded in 3 workplaces at the fuel oil-fired boilers section from Bucharest-Progresul CHP (level 20, level 40, level 41), by 4 ÷ 9 dB(A).

In conformity with Labour Protection General Norms, the wearing of ear protectors [antiphons] as means of individual protection is imposed in these places.

In the Labour Protection Norms from most of the EU the maximum acceptable limit (MAL) is 85 dB(A). The reason for establishing this reference value is the apparition of the specific pathological phenomena generated by the exposure at noise (occupational hypoacusis and occupational deafness) As a result of this fact, even if there is no exceeding of the actual acceptable limit as per the Romanian legislation, there are workplaces having exposure values of ~85 dB(A) NAEC/S, we do insist in recommending the mandatory wearing of the antiphons by the personnel exposed.

B) Microclimate

The microclimate in the section fuel-oil-fired boilers and Turbine was evaluated during the cold season (December).

The instruments used were Assman psihro-meter (for dry and wet temperature) and glob-thermometer.

Microclimate parameters of interest were temperature, relative humidity, and caloric radiation. Microclimate measurements were taken in the working zone and in several zones from various rooms, the final values representing the average mean of these measurements, which are covering values for the characterisation of the work thermal ambient.

Relative humidity was determined on the basis of the hygrometer, depending on the values of the dry and wet temperatures.

The results of the microclimate measurements made at the studied workplace are shown in the table below.

Workplace		Dry Temperature (°C)	Relative Humidity of the Air (%)	Temperature on glob thermometer (°C)
Fuel-oil fired Boiler Section	level 20 m	17,2	72	17
	level 40 m (front boiler)	36	25	35,4
	level 40 m (front boiler)	35	40	35
	level 41 m (boiler drum 3)	24	63	23,4
	level 13 m	14,8	52	14,2
Turbine Section	level 6 mTA 3	13	59	13
	level 0 m	16,6	50	16
	Electric-driven pumps – District-Heating	21	46	20,6

Comparing the values of the measurements made at Bucharest - Progresul CHP with the values of the microclimate from the Labour Protection General Norms one can remark that the limits of the maxim acceptable limits (MAL) for heat radiation via the physical efforts of the employees (176 ÷ 300 kcal/hour) are not exceeded, except at the level 40.
From the point of view of the air relative humidity, in two workplaces (level 20 and level 40) the calculated values are not ranging in the thermal comfort interval (40 ÷ 65%).
In conformity with the Labour Protection General Norms, for the workplaces where the temperature of the air exceeds constantly 30°C saline carbogaseous water (1 g NaCl / l) at a quantity of 2 ÷ 4 l / person / shift, is distributed to the personnel at a temperature of 16 - 18°C.

3.1.2. Chemical and physical-chemical factors

Sampling was made in accordance with the Labour Medicine Methodological Norms. For the sampling of the chemical noxes, the level breathable for the persons investigated was selected as a common element for all the determinations carried out.
There have been dozed the chemical noxes resulted from the operations taking place in Bucharest-Progresul CHP under normal operation conditions
Instruments used for determinations were:
* for sampling the specimen:
✓ Casella and SKC own pumps
✓ Multiwarn-Drager gas analyser with specific electro-chemical sensors of the Drager Senzor XS ECNO – 68 09 125, EC CO – 68 09 005 type.
✓ Whatman glass fibre filters
✓ absorbers and micro-absorbers
* for determination:
✓ spectrum-photometer UV/VIS Pye Unicam SP6-550
✓ Mettler analytical balance
✓ Drager indicating tubes.
Principles of the methods to determine the chemical substances are:

- For the determination of CO, NO_x from the atmosphere of the working zones there has been used a gas analyser of the Multiwarn-Drager type with specific electro-chemical sensors of Drager Senzor XS ECNO – 68 09 125, EC CO – 68 09 005 type. The Drager electro-chemical sensors measure the partial pressure of the sampled gases. The noxes monitored diffuse through the membrane of the electrolyte containing a sensible electrode specific for each gas to be determined. The signal of the electrode is converted in electric signal and registered on the display of the analyser.
- To sample the aliphatic hydrocarbons the air sampled is aspired at a flow rate of 1,5 l/min. through an absorber containing 10 ml ethylic alcohol for 10 minutes; read it in UV at 255 nm wavelength;
- Drager indicating small tubes are used for sampling the ozone;
- Hydrochloric acid enters reaction with the SCN^- ion (from the potassium sulphur-cyanide) resulting in a weak dissociated compound $(HgCl_4)^{2-}$, which in the presence of the ferrous-ammonia alumen gives birth to a red calorimeterable compound.
- Toluene shows an absorption maximum in UV at 261 nm, through the absorption in ethylic ether;
- ammonia is determined with Nessler reagent, resulting in amidooximercuric iodine and amidomercuric triiodine of yellow colour, calorimeterable at λ=450nm;
- hydrazine enters reaction with p-dimethylaminobenzaldehyde, resulting in a coloured compound with calorimeterable quinoidic structure, calorimeterable at 470nm;
- natrium hydroxide (NaOH) enters reaction with the sulphuric acid solution that is put in evidence with bromcresol green solution in the turning domain of pH=3,8-5,2 and the modification of the colour from green into blue followed by the measuring of the extinction at 617nm;
- mineral oil air emulsions sampled in chloroform evidence an absorption maximum in UV at λ=265nm;
- dozing of trichloretylene through the absorption in UV at λ=210nm, in ethylic alcohol;
- sulphuric acid (H_2SO_4) is determined from the reaction of SO_4^{2-} nitrogenous lead, nonfelometerable at λ=420nm;
- ethylic ether is oxidised with a potassium dichromate acid solution. With the spectrophotometer appraisement of the dichromate consumed in this oxidation as related to a known quantity taken in work, the quantity of ethylic ether entered in the reaction is deduced. Extinction is measured at λ=430nm;
- the total of the powders retained is determined with CASELLA - Aerosol Monitoring System AMS950 type for power retaining.

The acceptable average and peak concentrations to which the relating of the found concentration was made are the ones from the Labour Protection General Norms of Romania .

From the chemical and physical-chemical determinations made in the Chemistry Department of Progresul power plant the following conclusions resulted:

✓ HCl had shown values close to the peak acceptable concentration at the HCl pumps situated in the regenerative node sector;

✓ Sodium hydroxide has exceeded the value of the average acceptable concentration (1 mg/m^3 air) by 2.79 times in the pre-treatment lab by 2.38 times in the demineralisation-softening stations and at the NaOH pumps from the regeneration node, by 2.83 times in the demineralisation-softening shift lab, by 2.14 times in the reagent preparing lab, by 2.62 times in the water analysis lab;

✓ hydrazine has exceeded the average acceptable concentration value in all the points where specimen were sampled, such exceedings were by 4.2-9.4 times higher;

✓ ammonia exceeded by 2.75 times the value of the average acceptable value (15 mg/m^3 air) in the preparing hall, and by 2.11 times at the dosing. There have been obtained concentrations which exceeded the level of the peak acceptable concentration (30 mg/m^3 air) at both ammonia preparing and dosing;

✓ toluene determinations evidenced an exceeding of the average acceptable concentration by 1,72 times (100 mg/m^3 air) in the oil-fuel oil analysis lab;

✓ level of the total powders was lower than the average acceptable concentration (10 mg/m^3 air).

Results of the powder determinations in the Fuel Section from Rovinari power plant are shown below:

- In most of the sampling points exceedings (except: levels 0 and 92) of the coal powders are present;
- The rooms are naturally ventilated what supposes the presence of some air currents which transports the particles from one place to another;
- The respective powder is very fine and light (the density of the coal dust is about 1500kg/m^3) what favours the diffusion of the particles and homogenisation of the concentration;
- The workplaces do not have an immovable position, the workers have to move from one room to another to either supervise or operate several machines;
- In the same room several machines of the same time operate while the quantity of powder released by each of them scatters inside the room.

NOTE: *According to Labour Protection General Norms and Order 1957/1999 the Maximum Acceptable Concentration (MAC) is the one for the powders with contents of free crystalline SiO_2 more than 10% and it was determined with the relation:* $\frac{50}{\%SiO_2} = mg/m^3$. *According to the experience of ICEMENERG there has been found out that in Romania coals are used with SiO_2 contents higher than 12,5%, therefore the total powders MAC is 4 mg/m^3. It worthies mentioning that at the time when powder concentrations have been determined, the coal fired had about 20% SiO_2 contents.*

4. Comparison of the results obtained in the measurement of the occupational noxes at the two power plants: Bucharest-Progresul & Rovinari CHP

A. Similarities:

Chemical Treatment and Electric Stations:

- Maximum Acceptable Limit (MAL) for the noise is not exceeded at any workplace.
- The values of the microclimate parameters (temperature, relative humidity, caloric radiation) from the batteries-chargers room are under the MAL for the level of the heat release through the physical effort of the workers.
- **Chemical Station :**

✓ Hydrochloric acid had values close to the values of the peak acceptable concentration of the HCl pumps in the regeneration node sector;

✓ Sodium hydroxide exceeded the value of the average acceptable limit (1 mg/m^3 air) in the pre-treating lab, demineralisation-softening room and NaOH pumps from the regeneration node, in the demineralisation-softening shift lab, reagent preparing lab and water analysis lab;

✓ Hydrazine exceeded the average acceptable concentration value in all the sampling points where the specimen were taken;

✓ Ammonia exceeded the average acceptable concentration value (15 mg/m^3 air) in the preparing and dosing room. There have been obtained concentrations which exceeded the peak acceptable concentration value (30 mg/m^3 air) at both ammonia preparing and dosing;

✓ Determinations of toluene evidenced the exceeding of the average acceptable concentration (100 mg/m^3 air) in the oil-fuel oil analysis lab.

- **Electric Repairing Workshop:**

✓ Dosing of the carbon monoxide evidenced no exceeding at average acceptable concentration (20 mg/m^3 air) in the work zone air;
✓ Nitrogen oxides exceeded the average acceptable concentration (5 mg/m^3 air) during the oxyacetylene flame welding of some big parts;
✓ Mineral oil exceeded the average acceptable concentration (5 mg/m^3 air) during the heating of the motor small parts in the mineral oil;
✓ Trichlorethylene determinations at the degreasing operations evidenced exceedings (at both small and big parts), the average acceptable concentration value obtained is 100 mg/m^3 air;
✓ Concentration of toluene determined has exceeded the average acceptable concentration value (100 mg/m^3 air) at the pulverising of the coating lacquer on the turbine stator, repainting of the turbine rotor, painting of the outside surface of the electro-motor coupling.

- **For the Sections: Boilers and Fuel oil**

✓ From the measurements performed in these sections there resulted that the Maximum Acceptable Limit of 87 dB(A)NAEC/S was exceeded in several workplaces from these sections. According to the Labour Protection General Norms the antiphons should be worn as individual means of protection.
In the Labour Protection Norms from most of the European Community countries, the Maximum Acceptable Limit is 85 dB(A). The reason for establishing this level is the apparition of the specific pathological phenomena generated by the exposure to noise (occupational hearing deficit and occupational deafness) when this threshold is exceeded. In conformity with Labour Protection General Norms, in these places it is imposed the wearing of ear protectors [antiphons] as means of individual protection.
✓ Comparing the microclimate measurement values obtained for the Boilers and Turbine sections with the values from the Labour Protection General Norms (Annex 11) one can notice that the maximum acceptable thermal limits for heat release due to the physical efforts of the workers (176 ÷ 300 kcal/h) is not exceeded with the exception of the level 40m.
✓ From the point of view of the air relative humidity, in two workplaces (at levels 20 and 40) the values calculated do not range within the thermal comfort interval (40 ÷ 65%).
In conformity with the Labour Protection General Norms, in the workplaces where the temperature of the air exceeds constantly 30°C, saline carbogaseous water (1 g NaCl / l) will be provided at a quantity of 2 ÷ 4 l / person / shift and distributed at 16 - 18°C temperature.
✓ Chemical noxes measurement (CO, NO_2, aliphatic hydrocarbons) showed that there are no exceedings of the average acceptable limits for NOx sampled from the investigated workplaces.

B. Dissimilarities

✓ Lime powder from the lime storage located in the chemical section of Rovinari power plant evidenced exceedings while no exceeding has resulted at Bucharest power plant; measures have been taken to retain the lime powder in the former case
✓ Battery chargers regeneration station*:* sulphuric acid determinations evidenced the exceeding of the average acceptable concentration value.
✓ During the determinations made at the level of the burners serving unit no. 6 from Rovinari power plant, the concentration of the carbon oxide had very high values, exceeding by 2, 3 times the maximum accepted value for CO in the atmosphere of the working zones.
✓ At all the sampling points of the solid fuel section from Rovinari power plant, exceedings of coal powders (except level 92) are present.
From the comparison of noxes existence similarities and dissimilarities in the two power plants, remark that the points where the occupational noxes exceedings exist, are in most of the cases, similar for all the sections where noxes exceedings have been found out. Consequently, irrespective of the type of fuel they fire, either liquid fuel (Bucharest Power Plant) or solid fuel (Rovinari power plant) there exist, in principle, the same types of occupational noxes exceeded for the same types of sections in the thermal power plants.

5. Comparative Analysis of the Results Obtained from the Health Condition Investigation for the Employees from the two Power Plants: Bucharest and Rovinari

A. Similarities:

Chemical Treatment and Electric Sections:

In the chemical treatment section the workers are occupationally exposed to the irritant gases (HCl, ammonia, hydrazine).
The clinic examination per apparata and systems, evidenced the following:

- Tegumentes and mucous membranes – pale tegumentes ;
- Osteoarticular apparatus – lumbodynia;
- Respiratory apparatus – inter-current respiratory disorders;
- Cardiovascular apparatus - palpitations, dispnoea;
- Digestive apparatus – dyspeptic syndrome.
- Urigenital apparatus – uterine fibroma, vesicle disorders;
- Nervous system – neuro-vegetative and sleeping disorders.

From the analysis of the data, predominant digestive and osteoarticular disorders and diseases have resulted.

Electric Operation & Repairing Section

In the electric section occupational exposure to irritant gases (H_2SO_4), powders, noise, unfavourable microclimate and vicious positions exist. 70% of the jobs are held dominantly by electricians.

The clinic examination per apparata and systems evidenced the following:

- osteoarticular apparatus – disorders of the lumbar column, polyarthritis, gonarthrosis.
- cardiovascular apparatus – precardialgia, cardiac disorders in APP
- digestive apparatus

From the analysis of the data, there results that the osteoarticular disorders are dominant.

Turbine & Boiler Repairing Sections

In this section occupational exposure to irritant gases (ammonia and hydrazine), powders, noise, unfavourable microclimate, vicious positions exist.

The clinic examination per apparata and systems evidenced the following:

- hearing apparatus – hearing deficiencies.
- nervous system – sleeping disorders, nervousness state, paresis in the inferior limbs
- tegumentes and mucous membranes – eruptions of tegumentes, conjunctivitis;
- osteoarticular apparatus – effort based lumbodynia, polyarthralgia and crackments at the mobilisation of the big articulations
- respiratory apparatus – bronchitis like disorders
- cardiovascular apparatus – pains of angina type.
- digestive apparatus – symptomatology of the gastroduodenal ulcer - dyspeptic syndrome type.

From the analysis of the data there result the following:

- hearing deficiencies evidenced as low hearing level at one or two ears, of unilateral or bilateral deafness type
- osteoarticular disorders prevail
- digestive disorders of the chronic gastroduodenite or gastroduodenal ulcer type
- respiratory disorders with bronchitis specific manifestations

B. Dissimilarities

At Rovinari power plant there exists a number of sections, which have not been investigated at Progresul-Bucharest power plant, with respect to the health condition of the employees. These sections are:

Hydro systems workshop

In the hydro systems workshop, workers are exposed to the noise and powders

The clinic examination per apparata and systems evidenced the following:

- tegumentes and mucous membranes - pitiriazis;
- osteoarticular apparatus – polyarthralgia and crackments at the mobilisation of articulations
- endocrine system – spasmophilia.

Coal mill-repairing section

In the section where coal mills are repaired, the workshops, central belt conveyers, crushing I,II,III, include the occupational exposure to dust, noise, unfavourable microclimate, physical efforts.

The clinic examination per apparata and systems evidenced the following:

- osteoarticular apparatus – polyarthralgia arthralgia, lumbodynia, crackments at the mobilisations of the big articulations.
- respiratory apparatus - nasal obstruction, irritate dry cough;
- cardiovascular apparatus - HTA;
- digestive apparatus - dyspeptic syndrome;
- urigenital apparatus – hypothyroidia, spasmophilia;
- nervous system and analysers – sleeping disorder, visual acuity disorders.

Analysis of the data obtained from the clinic examination indicates that 42.5 % from the investigated subjects have osteoarticular disorders represented by lumbodynia and polyarthralgia, out of which 52.8% are males and 41.2 % females; 52.9 % work in the respective workplace for about 11-20 years and 47 % work there for less than 10 years, while 17.6 % have osteoarticular pathological antecedents.

20% from the subjects presented dyspeptic like digestive disorders, 50 % are males and 50 % are females, 65.5 % are smokers; 37.5 % are alcohol drink consumers; 50 % from the subjects that have digestive troubles work in the respective workplace

for 11-20 years, and 30 % from the subjects have antecedents of the acute viral hepatitis and gastroduodenite type.

Mechanics Workshop

In the mechanics workshop the occupational exposure is predominant with noise, powders, vicious positions.

The clinic examination per apparata and systems evidenced the following:

- osteoarticular apparatus – articulation mobilisation crackments, lumbodynia, polyarthralgia;
- respiratory apparatus - accentuated vesicle murmur, effort dispnoea;
- nervous system and senses – eyesight disorders.

Analysis of the clinic examination data evidences 83% affecting of the osteoarticular apparatus with lumbodynia and arthralgia disorders, 66% from the subjects are over 40 years in age and work in the respective workplace for about 10 years.

Heavy equipment section

In the heavy equipment section the dominant occupational exposure is to noise and carbon oxide.

The clinic examination per apparata and systems evidenced the following:

- osteoarticular apparatus - rachitis remains, lumbago [discopatia];
- respiratory apparatus - cough with expectoration, pulmonary emphysema;
- cardiovascular apparatus - HTA with extrasystoles , mitral stenosis;
- digestive apparatus - dyspeptic syndrome;
- renal apparatus - urinary infection:
- nervous system - neurotic syndrome.

Consequently, at Rovinari power plant the following problems are specific for the health of the employees :

From the global analysis of all the data obtained from the investigation of the working conditions in correlation with the results obtained from the clinic and paraclinic medical examination, there appear a preponderance of the muscle-bone system disorders which are found in the sections and workshops: crushing, conveyer-belts, coal mill repair and mechanics workshops. This situation can be related to some working factors, such as: air currents, temperature variances, physical efforts. However the structure of the lot investigated indicates a majority in excess of 60 % subjects that are more than 30 years old. This issue suggests that in the ethnology of the respective disorders, the ageing physiological factors, through the wear of the articulations, degenerative inflammatory disorders, are the main roots of the respective morbidity category.

There has been found out a relative high percentage, namely 17.9 % of the subjects with respiratory function disorders. Most of these functional disorders are minor, respectively slightly restrictive non-functionality and minor diseases of the air ducts. While correlating the workplaces and the originating places of the subjects, there has been found out that more than 50% of the workers are coming from the crushing, boiler-turbine, belt-conveyer. In these sections, the highest concentrations of powders have been also determined.

Another argument to the sense of the occupational influence in the ethnology of these health disorders is the presence of the irritant type symptomatology (dry coughing mainly) is dominant with the subjects that originate from the perimeter of the same above-said sections and workshops. At the same time, there has been found out that only 18 % from the subjects investigated wear constantly the protection equipment.

Professional accurate diagnostics have been not possible because the smoking also causes the same medical manifestations. The data resulted from the investigation indicate that a large number of the subjects are cigarette smokers. Moreover in some sections or workshops all the workers are smokers. The tested lot evidenced that 53 % from the subjects are smokers. The analysis of some reference parameters of the respiratory functional tests, such as VEMS and MEF, evidences that the highest deviations from the normal values are at their highest proportion in those places where the highest proportion of smokers is. Otherwise, even in the lot investigated 17.9% from the subjects that have disorders of the pulmonary functions, more than 87% are smokers and all of them work in the respective workplace for more than 15 years.

Audiometer examination of 106 employees from the sections where the noise exposure is the highest evidences 8 subjects with hearing deficiencies. These subjects come from crushing, coal mills and turbines.

The psychological examination made with the above mentioned neurobehavioral battery tests evidenced modifications of the parameters, in more than 50% of the subjects originating from the crushing, coal mills, belt-conveyers, turbine sections. The most affected parameter has been the (visual and hearing) reaction time [feedback]. This situation is correlated with the noise factor existing in these workplaces.

A problem that requires special attention refers to the analysis of the carboxyl-haemoglobin. The sampling of the specimen from the subjects was made at the workplaces at the end of the shift III where 60 mg/m^3 CO concentrations have been found out.

At 4 subjects from the tested lot there have been found concentrations exceeding 10 % carboxyl-haemoglobin from the total haemoglobin. Although the number of smokers in this sub-lot is not very high (more than 85 %) the correlation with the high value of CO in the working environment cannot be avoided, being known that smoking only cannot touch such thresholds. Some programmes are recommended for the improvement of the ventilation systems and awareness of the employees in the relation with the workplaces**.**

The obligations referring to the periodical examination of the employees via medical investigations and analyses specific for the working conditions where the workers carry out their activity take place in a scheduled manner. At present the technical endowment of the medical unit of the enterprise is convenient and adequate.

6. Technical Solutions proposed for the attenuation of the noxes level

Measures for reducing the personnel exposure to the chemical and chemical noxes, aimed at diminishing the occupational risks, can be divided in 2 groups:

A. Technical-Organisational Measures

B. Medical Measures

C. Technical and technological solutions proposed for the attenuation of the occupational noxes from power plant

A. Technical-Organisational Measures:

1. Continuation of the researches aimed at finding out technical solutions applicable for the elimination of the occupational noxes from the technological process identified in the paper, by the replacement of the noxious matters and noxious technologies with another less noxious and less prejudicial ones;
2. Isolation of the noxes generating equipment or separation of the noxious technological processes from the places where the persons work (I&C, special cabins, thermal insulation, antiphon-isolation, etc.) in the zones specified in this paper;
3. Prevent noxes infiltration in the atmosphere of the workplaces (tightness, wet procedures to diminish the powders, local ventilation, etc.);
4. Reduce the concentrations (intensities) of the occupational noxes at the workplaces under the maximum acceptable limit by the help of the general ventilation and noise absorbers.
5. Provide the tightness/sealing of the machinery producing noise by the help of the technical solutions to be proposed by the subsequent research works.
6. Provide antiphons and impose the employees to mandatory wear them in the workplaces where the values of the noise determinations exceeded the Maximum Acceptable Limit (Boiler, Fuel oil, Turbine sections) and in those places where the noise determination values are at the limit which affect the hearing system.
7. Make delimitation as per the acoustic zones and remove as much as possible the people from the noisy machines:

✓ Eliminate the sources of noise or attenuate the intensity of the noise;

✓ Isolate the sources of noise using phonoinsulating materials;

✓ Acoustic correction of the working rooms to reduce the duration of the reverberation.

8. Mark with pictograms showing the obligation of wearing the protection equipment (caps, antiphons, masks) all the access points to the zones where Maximum Acceptable Concentration value was determined to be present;
9. Impede the occupational noxes action upon the employees or diminish its action as follows:

- reduce the physical and neuropsychic efforts ;
- corresponding working regime concerning the labour conditions;
- use the individual protection equipment – masks, gloves, antiphons, eyeglasses, etc.;
- provide and maintain the reliable operation of the hygienic-sanitary facilities (showers, bathrooms, vestiaries, etc.);
- provide the protection alimentation and have it consumed in the enterprise (in conformity with the Labour Protection General Norms, at the workplaces where the temperature of the air exceeds constantly 30°C saline carbogaseous water (1 g NaCl / l) at a quantity of 2 ÷ 4 l / person / shift, will be distributed to the personnel at a temperature of 16 - 18°C).
- establish a real program for training of the employees, including also medical topics, addressed to the personnel expose to noxes during the working process.

B. Medical Measures

Cognition of the occupational risk at the workplace through:

- Technological processes and working condition;

- Quantitative determination of the occupational noxes;
- Epidemiological studies.

Cognition of the occupational risk is also intended for the preparing of the following evidences:
- jobs with occupational risks
- technological processes with occupational risks
- worker exposure.

2. Recognition by the doctor of the enterprise of the workplaces which exceed the Maximum Acceptable Limit (noise, microclimate, chemical noxes) and the risks for the occupational diseases (occupational deafness/low hearing, etc.)
3. Medical examination before hiring according to the Labour Protection General Norms.
4. Medical examination for adapting between the 2nd and 3rd weeks after hiring when audiometer examination is made while after 3 months ORL and audiometer examinations are made.
5. Signal the cases of occupational hearing deficiency and etiological suspicion.
6. For the subjects found with modifications in the biochemical and clinic examinations, recommend::
- interrupt alcohol consumption
- give up smoking
- diminish overweight (if any)
- corresponding hygienic-dietetic regime
- consult the specialised medical service to establish the diagnostic and therapeutic condition

7. Periodical medical control according to the Labour Protection General Norms
8. Sanitary education that means informing and forming; it is addressed to the:
- technical management and administrative personnel with a view to establish the technical-organisational measures under efficient conditions and in the pre-established order.
- Employees, with a view to observe the rules referring to the individual hygiene, correct wearing of the individual protection equipment, diminishing smoking and alcohol drinking, first aid rules, cognition of the first symptoms for the acute intoxication, regular medical control, etc.

C. Technical and technological solutions proposed for the attenuation of the occupational noxes from power plant :

Chemical Section

a) Eliminate chemical noxes from the demineralisation-softening room and NaOH pumps from the regeneration node, hydrazine preparing and dosing room, ammonia preparing and dosing room:

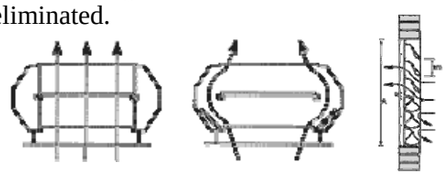
Technical solution:

Static ventilation system using the natural convection principle

The benefits of this system are:
- natural ventilation through convection;
- extraction of the occupational (chemical, physical-chemical) noxes;
- maintain the roofs clean and luminous.

The actual construction of the chemical section does not offer optimal conditions for the natural ventilation; this fact is usually omitted from the execution plans and design.

The ventilation system for noxes extraction is provided with:
- folding valves for any meteorological conditions
- metal, aluminium, glass or insulating material networks of a design that reduces the resistance of the air eliminated.



The ventilation system for noxes extraction can be mounted either on the roof or in the walls.

b) Elimination of the chemical noxes from the chemical labs (pre-treatment, demineralisation-softening shift, reagent preparing, water analysis, oil, fuel oil analysis labs):

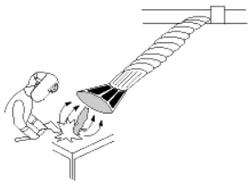
Technical Solutions:

1. Execution of the lab niches should be made of corrosion proofed materials (polypropylene, stainless steel)
2. NOx removal system from the niche should be of the hood type provided with active carbon filters which can be replaced regularly
3. Niches should be better sealed through the construction of rail-mounted windows provided with rubber edge and termopane window.
4. At the lower part of the niche there should be made a system for the introduction of an additional fresh air current which facilitates a better circulation of the air.

c) Elimination of the chemical noxes from the hydrazine preparing & dosing room, ammonia preparing & dosing room

Technical solution:

Fixed or movable hoods located in the hydrazine and ammonia preparing & dosing places. Such hoods provide about 0.5m/s circulation of the air around the preparing and dosing place.



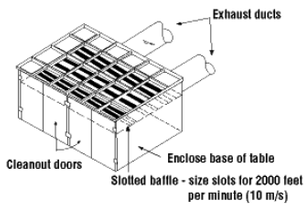
Electric Section

a)Elimination of the occupational noxes from the electric workshop during the welding operation.

Technical Solutions:

a.1. Local ventilation

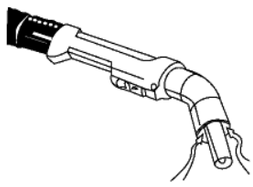
- provide a movable grate system which permits the closing and opening of the workspace, the system being constructed so that the speed of the air flow should be sufficiently high to assure the efficient removal of the occupational noxes from the workplaces (especially for welding).



a.2. Mobile (flexible) hoods located in the place where welding operation is performed; such hoods provide a rate 0.5m/s for the circulation of the air around the place where the welding operation takes place.

a.3. Special systems for fumes extraction

These systems exhaust the extraction into an external system. They are very expensive, however they are very efficient for the vertical surfaces and for the corners of the welding execution surfaces.



b) Elimination of the occupational noxes from the electric repair workshop during the unwinding of the small motor parts, degreasing of small parts with trichlorethylene, reconditioning of the motors

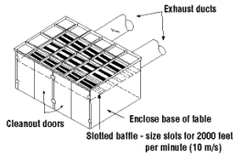
Technical solution:

b.1. Make, within the Electric station, separate ventilated enclosures where there can be performed: the unwinding of the small motor parts, degreasing of small parts with trichloroethylene, reconditioning of the motors.

c) Elimination of the occupational noxes from the battery chargers station

Technical solution:

c.1. Provide a better local ventilation by the help of a mobile grate system which permits the closing and opening of the workspace, constructed so that the speed of the air flow should be sufficiently high to assure the efficient exhaustion of the occupational noxes from the workplaces (especially for welding).



3. Boilers & Fuel-fuel oil Sections

a. Elimination of the noise

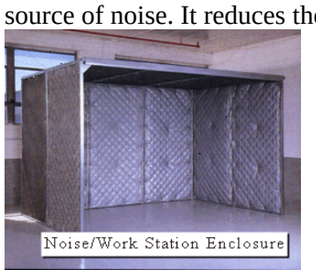
Technical Solution:

a.1. Noise absorption systems:

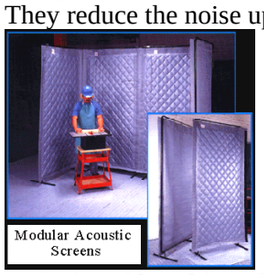
1. AFSC-122 System – based on fibreglass material. It is used to efficiently protection wrap the pipes. It is covered with a vinyl-protecting layer resistant to oil, water and dust.

2. AFNE-122 System – is a combined noise absorption and diffusion blocking system. It is made from a material based on fibreglass wrapped in a vinyl foil and fixed on a metal support. It is a

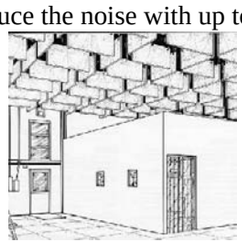
protection system to be constructed around the source of noise. It reduces the noise up 12-15 dB.



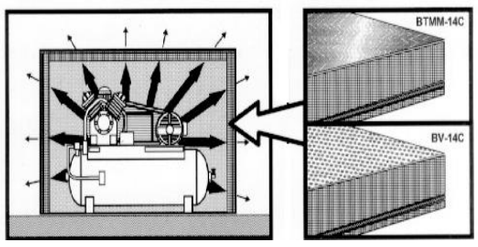
3. Modular Acoustic Systems – portable, easy to be moved and handled. They are fixed on steel rails by the help of some rubber wheels, which permit an easy motion of the noise absorbent panels. The panels are made from a material based on fibreglass, wrapped in a vinyl foil, fixed on a metal support. They reduce the noise up to 6-12 dB.



4. Noise Absorbing Screens – made of porous materials: fibreglass, mineral wool, sponge rubber, wooden wool, synthetirized metal. The screens are built in the ceiling and they absorb both high and low frequency noises. The absorbing screens can reduce the noise with up to 10 dB.



5. System for pump noise attenuation – system for pump embedding. The embedding material is made from metal or vinyl. It reduces the noise between 20 – 40 dB.



The following technical solutions are suggested for the Fuel Section:

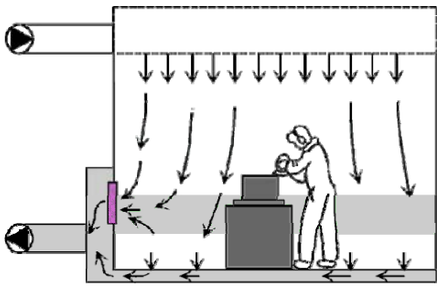
- the most efficient solution aims at combating the scattering of the powders in the powder generation places (encapsulation of the powder generating equipment and diminution of the air pressure inside it);
- dilution of the powder concentrations via ventilation in the workplaces.

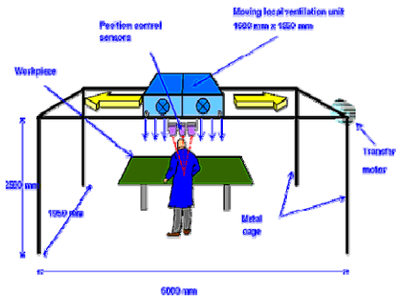
Solutions are suggested via ventilation:

- introduction of the conditioned air
- general exhaust
- local exhaust
- natural ventilation
- fresh air caption and introduction instead of the exhausted polluted one

- air humidifying. Through the conglomeration of dust particles, their weight increases, facilitating thus the falling down on the soil
- maintain continuous cleanness through the caption of the powders from the soil by the help of a mobile vacuum cleaner.

Examples of local ventilation:





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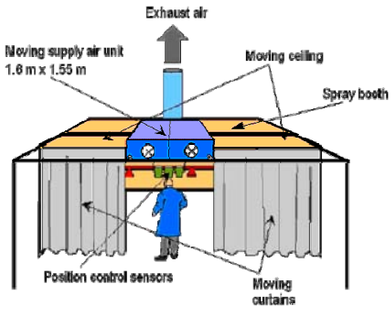

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