Assessment of Workers’ Occupational Exposure in The Context of Industrial Toxicology

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Abstract. Knowledge and assessment of occupational risks in every workplace is the main objective of the prevention of occupational illnesses. The ultimate goal of safety and health at work is to protect life, integrity and health of workers against the risks of accidents and professional diseases that may occur in the workplace. This paper approaches the measurement of workplace respirable dust and microclimate parameters at a Romanian branch of a multinational company, in order to analyse the results in terms of safety and health of workers. The means of investigating the studied objective involved knowledge of the working environment, choice of pollutants, sampling, analysis and interpretation of sampled materials, as well as equipment and working methods. The research started as a result of an employee complaining about headache, respiratory discomfort and nasal congestion. The most frequent noxae measuring takes place in a working environment with developed industrial activities generating physical and chemical agents. This paper investigated the presence of noxae in workplaces located in Open Space offices where the main activity is IT. These spaces are ventilated by an air conditioning system, windows are fixed and the floor is carpeted on the entire surface. Research has led to the fact that the measured noxae (dusts, microclimate) have exceeded the maximum permissible concentration required by national legislation, this being an unexpected outcome for the company manager. These concentrations may be due to staff traffic, high number of employees and lack of natural ventilation. Following the evaluation results, a number of technical and organizational measures, aimed at improving the workplace atmosphere, was recommended.

1. Introduction

Working capacity and health of workers are influenced by the type of work, its structure, interrelations within the work group and the structure of work place.

Ensuring the health of workers exposed to occupational pollutants Law 319, 2006 [1] represents an important objective to increase the quality of life. The fundamental concept of national legislation [1] places the head of the economic trader in the centre of activities to ensure health and safety of employees and risk prevention. In this regard, the director or his equivalent must develop an intense work of attracting staff into identifying and evaluating occupational hazards, because this activity should be a constant concern of all participants [2, 3].
Occupational environment in which the worker's activity takes place is characterized by a specific physical and chemical agent compound that can have adverse influences on health of the employees. These agents (microclimate parameters, toxic substances, particulate matter, unfavourable lighting etc.) are called adverse or harmful agents [4].

Along with adverse or harmful factors, technological processes, the object of worker’s activity or the nature of work also entail working conditions.

This paper highlights the occupational hazards affecting workers operating in the IT sector and highlights the risks to their health.

2. Case study conducted at workplaces in IT sector

The challenge of this research was set by the fact that in most situations, measurement of occupational noxae is carried out in places where technological processes are developed and rarely in offices, where only IT activities take place. Both managers and occupational health and safety specialists consider that, in such environments, noxae cannot exist. During 2015, INCD INSEMEX Petrosani conducted measurements of particulate matter and microclimate parameters (temperature, humidity, air speed and illumination level) at workplaces of traders operating in the IT field. To achieve this goal, it was necessary to quantify the level of occupational exposure to noxae present in the workplaces by performing measurements of all types of pollutants likely to exceed the maximum limits allowed by the national legislation.

2.1. Description of sampling sites

The considered company operates in a building with "Open Space" floor plan (large rooms and open-plan offices shared by a large number of employees), having carpeted floor, fixed windows and artificial ventilation performed by an air conditioning system that runs in all seasons.

Respirable dust and microclimate conditions sampling places (Figures 1-4) in the work environment have been carefully selected, being located on the walkways between offices, since the worker’s movement generates a large proportion of respirable particulate suspension.

![Figure 1](image-url)  

**Figure 1.** Location of sampling points for measuring concentration of respirable particulate matter and microclimate conditions for 2nd floor - Open Space; 1, 2 – particulate matter sampling points; 1, 2, 3, 4, 5, 6, 7, 8 – microclimate measuring points
Figure 2. Location of sampling points for measuring concentration of respirable particulate matter and microclimate conditions for 3rd floor - Open Space

Figure 3. Location of sampling points for measuring concentration of respirable particulate matter and microclimate conditions for 4th floor - G.N.O.C.; 1, 2 – particulate matter sampling points; 1, 2, 3, 4, 5, 6, 7, 8 – microclimate measuring points

Figure 4. Location of sampling points for measuring concentration of respirable particulate matter and microclimate conditions for 5th floor - Open Space; 1, 2 – particulate matter sampling points; 1, 2, 3, 4, 5, 6, 7, 8 – microclimate measuring points
2.2. Methodology for measuring the respirable particulate matter in the work environment

Measuring respirable particulate matter in the work environment is performed in accordance with the procedure of INCD INSEMEX Petrosani, accredited by RENAR [5]. The concentration of respirable particulate matter (PM4) was gravimetrically measured, according to STAS 10813/76. The method consists of absorbing air from the workplace atmosphere and retaining particulates on type FM filters. To measure a respirable and inhalable particulate matter, the following equipment found in the endowment of INCD INSEMEX Petrosani, was used: APEX and FLITE type sampling pump (Figure 5, 6).

![Figure 5. APEX sampling assembly (For sampling total respirable particulate matter)](image)

![Figure 6. FLITE sampling assembly (For sampling respirable particulate matter)](image)

2.3. Methodology for measuring microclimate parameters

Workplace microclimate is characterized by temperature, humidity and air currents. All microclimate agents act combined and concurrently on a human body. Air temperature is crucial, the other parameters just augmenting or diminishing effects of temperature. Workplace microclimate conditions must ensure maintenance of human body’s thermal equilibrium according to the activity performed.

Unfavourable microclimate is defined as the ensemble of microclimate agents, whose combined action exceeds the body’s adaptive capacity, overloading the thermoregulatory system to maintain thermal equilibrium. Overloading the thermoregulatory system generates heat stress.

Overall, these parameters exert a certain influence on the human body, human mood and work performance.

Working environment microclimate parameters measurement was performed in accordance with procedures of the Toxicology Laboratory within INCD INSEMEX [6] authorized by the Ministry of Health, Department of Public Health and Control of Public Health [7].

For performing measurements of microclimate parameters we used the AMI 300 device (Figure 7), found in the endowment of INCD INSEMEX Petrosani, which is a multifunctional tool for measuring temperature, humidity and air speed.

![Figure 7. AMI 300 device for measuring microclimate parameters](image)
3. Results and discussion

Measurements performed by specialists within INCD INSEMEX PETROȘANI on concentrations of respirable particulate matter and microclimate parameters in workplaces of the considered economic trader with activities in IT area are presented below, in table 1.

Table 1. Measurements results for respirable particulate matter concentration and microclimate parameters

| No | Place of measurements | Respirable particulate matter | Maximum admitted concentration HG 1/2012 [mg/m^3] | Average speed of air currents [m/s] | Average temperature [°C] | Average relative humidity [%] | Average illumination [lux] |
|----|------------------------|-------------------------------|-----------------------------------------------|------------------------------------|--------------------------|-----------------------------|--------------------------|
| 1  | 2nd floor; Open Space | 12.92                         | 10                                            | 0.04                               | 25.5                     | 33.2                        | 585                      |
|    |                        |                               |                                               | 0.05                               | 25.1                     | 33.9                        | 156                      |
|    |                        |                               |                                               | 0.03                               | 25.2                     | 33.6                        | 208                      |
|    |                        |                               |                                               | 0.05                               | 25.4                     | 33.3                        | 340                      |
|    |                        |                               |                                               | 0.05                               | 25.1                     | 34.1                        | 128                      |
|    |                        |                               |                                               | 0.04                               | 25.2                     | 33.9                        | 365                      |
|    |                        |                               |                                               | 0.05                               | 24.9                     | 33.8                        | 386                      |
|    |                        |                               |                                               | 0.04                               | 25.2                     | 33.8                        | 731                      |
|    |                        |                               |                                               | 0.07                               | 25.4                     | 36.2                        | 385                      |
|    |                        |                               |                                               | 0.06                               | 25.1                     | 36.4                        | 1075                     |
|    |                        |                               |                                               | 0.07                               | 24.9                     | 36.3                        | 305                      |
| 2  | 3rd floor; Open Space | 5.65                          | 10                                            | 0.06                               | 25.1                     | 35.9                        | 431                      |
|    |                        |                               |                                               | 0.07                               | 25.3                     | 36.1                        | 415                      |
|    |                        |                               |                                               | 0.07                               | 25.3                     | 35.9                        | 1055                     |
|    |                        |                               |                                               | 0.05                               | 25.1                     | 36.2                        | 824                      |
|    |                        |                               |                                               | 0.07                               | 25.3                     | 35.9                        | 510                      |
|    |                        |                               |                                               | 0.09                               | 23.6                     | 38.8                        | 195                      |
|    |                        |                               |                                               | 0.06                               | 23.8                     | 36.7                        | 225                      |
|    |                        |                               |                                               | 0.07                               | 23.8                     | 36.8                        | 140                      |
| 3  | 4th floor; G.N.O.C    | 12.52                         | 10                                            | 0.06                               | 23.7                     | 36.8                        | 229                      |
|    |                        |                               |                                               | 0.05                               | 24                      | 37.1                        | 282                      |
|    |                        |                               |                                               | 0.07                               | 24.1                     | 37.2                        | 325                      |
|    |                        |                               |                                               | 0.1                                | 25                      | 32.8                        | 291                      |
|    |                        |                               |                                               | 0.02                               | 24.9                     | 32.7                        | 338                      |
|    |                        |                               |                                               | 0.08                               | 22.2                     | 38.3                        | 310                      |
|    |                        |                               |                                               | 0.07                               | 22.3                     | 38.2                        | 466                      |
| 4  | 5th floor; Open Space | 17.20                         | 10                                            | 0.08                               | 22.5                     | 38.4                        | 865                      |
|    |                        |                               |                                               | 0.06                               | 22.4                     | 38.5                        | 540                      |
|    |                        |                               |                                               | 0.08                               | 22.3                     | 38.4                        | 180                      |
|    |                        |                               |                                               | 0.07                               | 22.9                     | 38.5                        | 195                      |

Analysis of results (found in Table 1), shows that microclimate parameter values do not exceed the maximum set out in the Guide for safety and health at work, completed by the National Research - Development Institute for Labour Protection "Alexandru Darabont" Bucharest, and the measured lighting values are compassed between 128-1055 lux, showing that office lighting is sometimes unfavourable for workers [7].

Analysis of the presented results shows that the concentration of particulate matter in the considered work places exceeds the limit allowed by legislation in force by values compassed between 2.52 mg/m^3 and 7.20 mg/m^3.

The graphical representation of respirable particulate matter concentration and microclimate conditions in the considered workplaces are shown in Figure 8.
4. Conclusions

The results of the microclimate measurements carried out in workplaces within the economic trader’s environment and show that the temperature had normal levels, compassed between 22.2 ÷ 25.5 °C, having no influence on the relative humidity values which were 33.2 ÷ 38.8%, air speed was relatively low 0.043 ÷ 0.073 m / s and for the lighting were obtained values between 128-1055 lux.

Currently, national legislation does not set limits for microclimate and lighting parameters, but the guide “General Norms for Labour Protection” or the “Guide for health and safety at work”, completed by the National Research - Development Institute for Labour Protection "Alexandru Darabont" Bucharest, may be consulted as they list the recommended values, [7].

The concentration of respirable particulate matter in analysed workplaces exceeds the limit set by legislation in force, with values ranging from 12.52 mg / m³ to 17.2 mg / m³, except for 3rd floor - Open Space where the concentration of particulate matter is within the limits allowed by law. Therefore, a number of technical and organizational measures is recommended, including replacement of existing carpets with hardwood floors or other flooring that does not retain dust, installation of ventilation systems so as to ensure effective ventilation, periodic replacement of air conditioning filters. The effect of environmental conditions (temperature, humidity, pressure, heat environment and heat stress) has significant influence on worker’s performance. Knowledge of workplace microclimate by the enterprise’s management allows for decision making and taking appropriate measures to improve working conditions. The case studies demonstrated that in the work done in the office (multinationals), there may be concentrations of pollutants, especially powders exceeding the permissible limit, which creates discomfort for the workers and damage of their health over time.

References

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