

# Harmonisation of standards related to limiting chemical risk associated with work processes

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Bostan I. Harmonisation of standards related to limiting chemical risk associated with work processes. *Ann Agric Environ Med.* 2013; 20(3): 460–464.

## Abstract

The presented paper tackles the issue of risk factors specific to work processes that involve the presence of chemicals. The reason that supports the present approach is the fact that the risks most likely to affect health in the workplace have been lately associated with the exposure of workers engaged in industrial activities to aggressive chemical agents. In order to tackle this problem, we shall resort to the normative regulations that have been adjusted upon Romania's inclusion in the European Union. The harmonization and alignment of the national standards – applied to the work systems that make use of various chemical substances likely to affect the health of the human resource – to the European guidelines and regulations has brought about a significant improvement in workplace security practices. Consequently, the arguments and demonstrations in the presented study are based on elements of the European acquis and the Romanian regulations which are all related to the chemical risk factors generated by harmful chemicals, or the potentially accident-prone properties of the substances used in work processes.

## Key words

hazardous chemicals, aggressive agents, personnel health, risk assessment, workplace security, normative alignment, European recommendations, national standards

## INTRODUCTION

All the Member States of the European Union are presently undergoing a realignment of workplace security and health policies, by taking into consideration all categories of risk. The main objective set by the European Commission is, obviously, 'the constant, sustainable and homogenous reduction of occupational accidents and diseases', the short-term objective being that of diminishing the total incidence rate of these accidents – for 100,000 EU workers by at least 25% [1].

The national strategy on workplace security and health 2008–2013, outlines the main priorities and objectives on a national level in the respective field, having been drawn up in agreement with the needs related to the development of Romania, and to the objectives of the community strategy [2].

The cited document mainly aims at constantly and significantly reducing the number of workplace-related accidents and occupational diseases, as well as constantly improving the level of workplace security and health. In this respect, one needs to better understand the chemical risks in the workplace, given the fact that a chemical substance can affect health if inhaled, ingested, or if coming into contact with the skin or the eyes, and it may equally be inflammable, explosive, or may be highly chemically reactive [3].

The development of risk prevention research, to a certain extent, has been an important strategic objective in the past, when the cases of work-related accidents and occupational diseases have decreased, although certain indicators still maintain very high levels. For instance, the average working days lost indicator has recorded a relatively visible increase: 66.5 in 2004 and 71.7 in 2007 (in the period preceding the accession of Romania to the European Union) (Fig. 1).

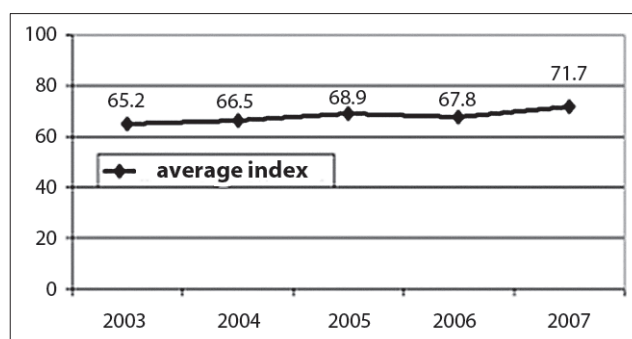


Figure 1. Evolution of the severity and working days lost indicator in the period preceding the accession of Romania to the European Union 2003 – 2007. (Source: Statistics of the National Centre for Methodological Coordination and Information on Occupational Diseases of the Institute of Public Health, Bucharest, Romania 2009, at: <http://www.mmuncii.ro/pub/img/site/files/>).

Occupational poisoning and exhaustion amount to 67.94% of the total exposed workers [4]. In direct relation to the present topic, the percentage of 16.58% of the total number under analysis are workers exposed to chemical gases and 15.48% exposed to powders.

The occurrence of occupational morbidity has increased during 2006–2007 (the last two years of the period prior to the accession of Romania to the European Union) (Fig. 2).

The following new cases of occupational hazards are the most likely to occur: loss of hearing caused by noise – 302, silicosis – 268, chronic bronchitis – 152, chemical substance poisoning – 122, locomotor system conditions – 117, bronchial asthma – 119 [4].

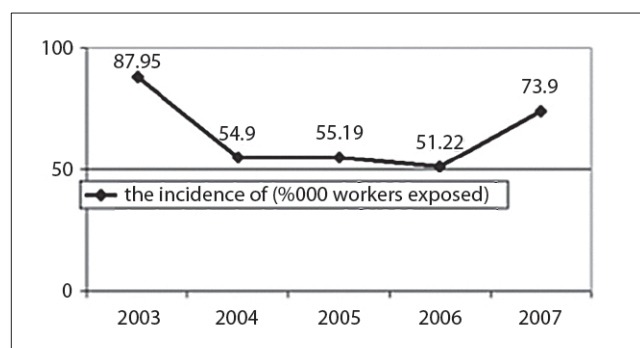
## MATERIALS AND METHODS

The presented study relies on the European acquis and the Romanian regulatory Acts related to the risk factors affecting

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Received: 19 January 2012; accepted: 2 February 2013





**Figure 2.** The occurrence of occupational diseases (in the period preceding the accession of Romania to the European Union: 2003 – 2007) (Source: Ibid.)

the working processes involving the presence of harmful chemical substances. Given the fact that the risks most likely to affect the personnel's health are those related to the direct exposure of workers developing industrial activities to aggressive chemical substances, certain methodological guidelines related to these risks must be highlighted, based on professional scientific studies.

The question that must be addressed is whether the personnel – directly operating in the environment where the substances or compounds are found, and which, because of their physical-chemical or biological properties and usage (or mere storage at the workplace) – is protected by the existing regulations against the risks that may affect their security and health.

Certainly, the fact has also been considered that employees may be exposed to harmful chemical substances in the working environment, either by accident (explosions, fire, damaged pipes or tanks, etc.), or during usage, handling or transport, the effects consisting in poisonings, burns, fires, irritations, lesions or explosions. This may be the case since, during technological processes, the workers exposed to harmful chemicals can be affected if they inhale powders, gases or vapours (for instance, exposure to cadmium powder can cause diseases of the lungs or kidneys), if they ingest powders, liquids (the ingestion of inorganic mercury salts can cause mercury poisoning), if their skin comes into contact with solids, powders or liquids, etc. (certain substances can be absorbed through the skin, causing skin conditions, for instance organic solvents cause contact dermatitis).

The resulting conclusions reflect a relatively normal outlook on the working practices that make use of various chemicals that may affect the health of the human resource, a state explained by the fact that Romania has fully adopted Council Directive 89/391/CEE of the European Union that establishes the general guidelines, as well as the rights and obligations of the employers and of the workers, related to the provision of a safe and healthy working environment and the measures employers must take in this respect.

## RESULTS AND DISCUSSION

**Investigating risks in the case of occupational poisoning caused by the presence of chemicals.** A harmful chemical substance is defined as any substance or compound which, because of its physical-chemical, chemical or biological properties and usage or presence in the working environment, can be a risk for the safety and health of the workers. During

their work, employees can be exposed to harmful chemical substances, either accidentally (explosions, fires, damaged pipes or tanks), or currently, during use, handling or transport.

The most likely effects induced by the exposure to the harmful chemical substances consist in [3]: poisoning, burns, fires, irritations, lesions and explosions.

Risk has been defined by ISO 8402:1995/BS4778 as: 'the combined possibility or frequency of occurrence of a defined hazard and the seriousness of the consequences' [5]. According to some authors [6], the same concept is defined as a mathematical probability of the consequences resulting from harming a part of a whole during a certain period of time:

$$R = C \times P \times \{F\} \quad (1)$$

where:

R – risk

C – consequences

P{F} – probability of occurrence of the harmful event.

The effective calculated risk must be compared with an accepted  $R_a$  risk, as a result of assimilating certain criteria as defined by the owners, the users or legislative systems. Risk can be minimized either by lowering the probability of harmful occurrences or by taking measures to alleviate the consequences.

Scientific studies have advanced several synthetic formulas to be applied when calculating risk, as follows [7]:

**A.** The general formula includes expressing risk (R) through probability quantification scales (P) of damage occurrence and severity (G) of the damage:

$$R = P \times G \quad (2)$$

In these terms, the probability encloses hidden unspecified elements of the risk.

**B.** Another, more detailed formula emerges by explicitly expressing the factor that takes the exposure into account (E):

$$R = E \times P \times G \quad (3)$$

This formula emphasizes the factors that can be influenced in order to modify the risk: exposure E (through work management), the probability P of damage occurrence during exposure (through collective prevention activities) and severity of the damage G (through individual protection measures).

**C.** The resort to detailing and completion with the factor (F), demonstrating that the risk can be reduced both by professional training and by the participation of workers according to their technical skills, will result in:

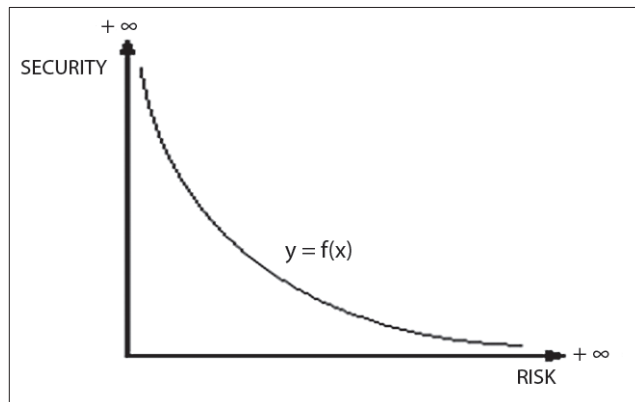
$$R = E \times P \times G \times F \quad (4)$$

Precision in establishing priorities or decisions obviously depends on the precision with which parameters G, E, P and F have been measured, and these estimates require the collection of data, inspection of the premises and discussions with workers about the exact nature of their activity.

Moreover, prevention requires the most effective means of reducing risk, entailing the presence of one or more components: reducing exposure time, improving the quality of the work and protection equipment.



However, when referring to the specific topic of this study, the graphic representation of the border between the accepted and the unaccepted risk level is outlined in Figure 3.



**Figure 3.** Border between acceptable and unacceptable risk levels. (Source: C. Vonica and D. I. Bardac, 'The occupational health risk assessment', In: M. Bejan (ed.), *Risk Assessment*, UTPRES & Mega Publishing House, Cluj Napoca 2008, p. 370).

The optimization of the prevention of work related accidents and occupational diseases in a system must start with the (re)assessment of the risks in the system, and is actually a process of assessing the risks threatening the security and health of the workers due to the hazards present in their working environment.

The inspections aim at systematically checking all the aspects related to work, considering everything that can cause harm, whether the hazards can be removed and what are the preventive or protective measures that should be taken in order to diminish the risks. The fact cannot be overlooked that by diminishing risks in this respect, the motivation of workers will be significantly boosted [8].

When a risk is identified, the most important step is to see if it can be removed. If this is not the case, the risk should be kept under control [9]. Any enterprise must develop at least one global, or detailed, risk assessment if need be.

According to SR-EN-ISO:1050 (Machine security – Risk assessment principles), these assessments and analyses should be conducted by the producers or the suppliers, as part of the compliance agreement [10].

When assessing risks, the following should be taken into account [3]: the harmful properties of the identified chemical substances, both separately and as a whole, the necessary prevention measures, usage, work equipment, volume, pressure and temperature, instructions on using these substances, exposure to harmful chemical substances (specifics, level and exposure time), reported problems/accidents/distress that have occurred and are related to the presence of those chemicals, etc.

A harmful chemical can bring about the risk of occupational poisoning or work related accidents [3] because of its biological properties, radioactivity, flammability, explosive proneness, etc. The existing hazards and risks related to the presence of certain chemicals are listed below (Tab. 1).

**Table 1.** Hazards and risks related to the presence of chemical substances.

Types of hazards	Risk description
<b>Very toxic</b>	<b>Very toxic</b> – substances and compounds which, if inhaled, ingested or absorbed through the skin in very small quantities, can cause death or chronic or acute damage to health. <i>Examples: cyanhydric acid arsenious anhydride, Parathion.</i> Depending on the quantity, these substances can cause irreversible effects after a single exposure, serious health damage after repeated or prolonged exposure, as well as cancerous and teratogenic effects if inhaled, swallowed or absorbed through the skin.
<b>Toxic</b>	<b>Toxic</b> – substances and compounds which, if inhaled, ingested or absorbed through the skin in small quantities, can cause death or chronic or acute damage to health. <i>Examples: methanol, benzene, phenol.</i>
<b>Harmful</b>	<b>Harmful</b> – substances and compounds which, if inhaled, ingested or absorbed through the skin can cause death or chronic or acute damage to health; <i>Examples: ethylene glycol, xyllylene.</i>
<b>Corrosive</b>	<b>Corrosive</b> – substances and compounds which, if in contact with live tissue will have a destructive effect on the latter; <i>Examples: chlorhydric acid, with a concentration of more than 25%, sodium hydroxide (caustic soda) with a concentration of more than 2%.</i>
<b>Irritant</b>	<b>Irritant</b> – non-corrosive substances and compounds which, through immediate, prolonged or repeated contact with the skin or mucous membranes, can cause inflammation. They can also inflame teguments, mucous membranes, airways, allergies (allergenic substances), eczema. <i>Examples: ammoniac between 5 – 10 %, chlorhydric acis between 10 – 25 %, acryl amides.</i>
<b>Extremely flammable</b>	<b>Extremely flammable:</b> liquid chemical substances and compounds with a very low flash- point, a very low boiling point, as well as gases that catch fire in contact with air at normal air pressure and temperature. They may catch fire from an energy source (flame, spark, etc.), even at temperatures below 0 degrees Celsius; <i>Examples: hydrogen, acetylene, ethylic ether.</i>
<b>Highly flammable</b>	<b>Highly flammable:</b> substances and compounds that can heat up and then catch fire on contact with air at ambient temperature, without any energy input; or solid substances and compounds that can easily catch fire after a short contact with an ignition source, and that continue to burn or consume itself after the source has been removed; or liquid substances and compounds with a very low flash- point; or substances and compounds which, on contact with water or humid air, discharge highly flammable gases in harmful quantities; <i>Examples: acetone, ethylic alcohol.</i>
<b>Flammable</b>	<b>Flammable:</b> Liquid substances and compounds with a low flash-point; they may catch fire on contact with an ignition source (flame, spark, etc.); <i>Example: white-spirit.</i>
<b>Explosive</b>	<b>Explosive:</b> solid, liquid, paste or gelatinous substances and compounds that can have an exothermic reaction in the absence of oxygen from the atmosphere, immediately discharging gas, and which, under determined testing conditions, detonate, cause a rapid deflagration or, under the effect of heat, explode when partially closed; they can explode in the presence of flames, friction or shock; <i>Example: nitroglycerine.</i>

Source: B. Nilson and E. Zamfirache (coord.), Reducing the workers exposure to harmful chemical substances in the working environment – The Ministry of Work, Social Solidarity and Family – Work Inspection, Bucharest 2002, p.18.

## HARMONISATION OF STANDARDS REFERRING TO THE LIMITATION OF RISKS FACED BY PERSONNEL PERFORMING WORKING PROCESSES USING VARIOUS CHEMICAL SUBSTANCES

**The impact of European standards.** The legal provisions related to workplace security and health comprise a series of normative acts that ensure the compliance of the national legislation with the community legislation in the field, by transferring the specific directives drawn up in the



implementation of the Framework Directive and referring to specific risks and activities. The coming into effect of Law No. 346/2002, referring to the insurance for work related accidents and occupational diseases [11], in the field of the regulations related to workplace security and health, as part of the social security system that exists in all the member states of the European Union [2].

The fundamental law of Romania stipulates at Art. 22, paragraph (1) [12]: 'The right to life, as well as the right to physical and mental integrity of the people is guaranteed...', and Art. 38, paragraph (2) provides that 'employees have the right to work social security. The protective measures refer to work security and hygiene...'. Moreover, the Work Code [13] stipulates at Title V, the obligations of employers in relation to workplace security and health: 'The employer must ensure the security and health of the workers, in all work related issues', and Art. 173 (1) stipulates that: 'As part of his own responsibility, the employer will take the necessary measures to protect the security and health of the employees, including for activities related to the prevention of occupational hazards...'.

Given the importance of risk assessment, this obligation is also reiterated in the Government Decrees of 2006 that transfer the European directives in the field of workplace security and health [14] [15]. The law for work security and health of the same year [16] also refers to the obligation of employees to organize workplace security and health activities in order to prevent work related accidents and occupational diseases.

The objectives of the workplace security and health activities for business entities, as stipulated by the national standards [16], are mainly to identify and eliminate risk factors at the source, assess the risks that cannot be removed and establish the measures to be taken in order to counteract their effects.

**Transfer of Directive 2009/161/EC establishing a third list of indicative occupational exposure limit values.** Directive 2009/161/EC [17] is the result of adopting and implementing the strategies of assessment and limitation of the risks brought about by hazardous chemicals, on a community level. The latest findings in the field, related to the effects of hazardous substances on the human body, have underlined the need to establish or revise the occupational exposure limit values for a group of substances.

Consequently, a third list of indicative occupational exposure limit values had been developed in the annex of the aforementioned directive and including a number of 19 hazardous substances. Of these substances, 16 have had their previous values changed, while the remaining three were mentioned for the first time with their respective limit values [18].

Moreover, the need to change Directive 2000/39 also arose from the introduction of a short term limit value for 'phenol', a substance that does not exist at present.

Thus, Romania, as a member state, was obliged to apply the legislative norms and administrative standards in order to comply with the provisions of Directive 2009/161/EC by 18 December 2011. The national normative Act that establishes the regulations in the field is Government Decree No.1218/2006, referring to the minimum security requirements for ensuring the protection of workers against the risks related to the presence of chemical agents [19], a decree that must be changed in order to be in alignment with the provisions of the new directive.

The alteration must establish occupational exposure limit values that would ensure the protection of workers if their professional activity entails the use of three new chemical agents, as well as revision of the previously set limit values in the case of the remaining 16 chemical substances [20].

Consequently, apart from the listed chemical agents from Annex 1 to Government Decree No.1218/2006 – National mandatory limit values for occupational exposure to chemical agents [19] – also included are [20]: Bisphenol A (inhalable dust), n-Methyl-2-pyrrolidone and Tertiary-butyl-methyl ether.

Furthermore, the normative measures to be taken by regulatory bodies will forbid the production, manufacturing or use at the workplace of [20]: 2 naphthylamine, 4 amino-diphenylamine and 4 nitrophenile (and their derivatives), as well as activities involving these substances. The restrictions do not apply if the chemical agent is present in another chemical agent, or it is chemical refuse, if its value is lower than the limit value of 0.1%, measured in weight.

The new limit values referring to powders are presented in Table 2.

**Table 2.** Limit values for powders.

No. crt.	No. CAS	Name	Limit value (8 hours)	Notations
1.	-	Asbestos	0.1 fibre/ cm <sup>3</sup>	Breathable fraction
2.	-	Cotton, Hemp	1 mg/m <sup>3</sup>	Inhalable fraction
3.	-	Kaolinite	2 mg/m <sup>3</sup>	Inhalable fraction
4.	409-21-2	Silicium carbide (carborundum)	10 mg/m <sup>3</sup>	Inhalable fraction
5.	-	Coal, coke, graphite (SiO <sub>2</sub> under 5%)	2 mg/m <sup>3</sup>	Inhalable fraction
6.	9004-34-6	Cellulose	10 mg/m <sup>3</sup>	Inhalable fraction
7.	-	Cereal	4 mg/m <sup>3</sup>	Inhalable fraction
8.	-	Portland Cement	10 mg/m <sup>3</sup>	Inhalable fraction
9.	14464-46-1	Cristobalite	0.05 mg/m <sup>3</sup>	Breathable fraction
10.	14808-60-7	Quartz	0.1 mg/m <sup>3</sup>	Breathable fraction
11.	-	Wheat flour	0.5 mg/m <sup>3</sup>	Inhalable fraction
12.	-	Polyamide fibres	1 fibre/cm <sup>3</sup>	Breathable fraction
13.	-	Glass fibres	1 fibre/cm <sup>3</sup>	Breathable fraction
14.	-	Plaster, gypsum	10 mg/m <sup>3</sup>	Inhalable fraction
15.	-	Furnace wool	1 fibre/cm <sup>3</sup>	Breathable fraction
16.	-	Mineral wool	1 fibre/cm <sup>3</sup>	Breathable fraction
17.	-	Glass wool	1 fibre/cm <sup>3</sup>	Breathable fraction
18.	-	Cedar wood	0.5 mg/m <sup>3</sup>	Inhalable fraction
19.	-	Softwood	5 mg/m <sup>3</sup>	Inhalable fraction
20.	-	Hardwood	5 mg/m <sup>3</sup>	Inhalable fraction
21.	-	Marble, chalk (calcium carbonate)	10 mg/m <sup>3</sup>	Inhalable fraction
22.	-	Mica	3 mg/m <sup>3</sup>	Inhalable fraction
23.	-	Powders without a specific effect	10 mg/m <sup>3</sup>	Inhalable fraction
24.	557-05-1	Zinc stearate	10 mg/m <sup>3</sup>	Inhalable fraction
25.	-	Talc without asbestos fibres	2 mg/m <sup>3</sup>	Inhalable fraction
26.	15468-32-3		Tridymite	Inhalable fraction
27.	-	Tobacco	10 mg/m <sup>3</sup>	Inhalable fraction

Note: (1) Fibres/cm<sup>3</sup>: refers to breathable fibres of under 3 µm diameter and over 5 µm in length, length/diameter ratio 3/1 and over; (2) mg/m<sup>3</sup>: milligrams per square meter of air at 20°C and 101.3 kPa (760 mm mercury column); (3) if the hardwood powders are mixed with other wood fibres, the limit value applies to all wood powders in the mixture.

Source: Compilation of the existing Tables in Government Decree No. 355/2007 and in Annex 3 of Government Decree No.1093/2006. <http://www.mmuncii.ro/pub/imagemanager/images/file/Proiecte%20legislative/280911Anexa2.pdf>





When referring to the updating of the national mandatory limit values of occupational exposure to chemical agents, established as a result of transferring Directive 2009/161/UE in the Romanian legal standards, the mentioned number (16) refers to [20]: cellulose acetate (2-Ethoxyethyle acetate), methyle cellulose acetate (2 2-Ethoxyethyle acetate), vinyl acetate, sulphuric acid and sulphuric anhydride, Ethylacrylate, Methylacrylate, cellulose (ethyl glycole, 2-Ethoxy ethanol) Dimethylformamide, Dioxane, phenol, Hydrogen sulphide, mercury, Methyl methacrylate, 2-Methoxyethanol and Carbon disulphide.

## CONCLUSIONS

Hazardous chemical agents can enter the body of a worker performing an activity when inhaled, ingested and, depending on their aggressiveness, may come into contact with the skin and sometimes even penetrate it. The consequences are extremely serious, since vital organs are severely affected and the substances may cause cancer, allergies of congenital malformations. Corrosive substances – acids and alkalines – cause severe lesions of the skin or loss of sight. Mainly, these types of substances from the working environment are the main cause of death and illnesses.

The optimization of work security in relation to this category of risks also requires that the respective chemical agents be prevented from coming into contact with the worker's body, or strict restriction of exposure to the harmful substance.

Thus, scientific findings (physical and chemical analyses, etc.) play a very important part, alongside the technical methods related to workplace security and, equally important, the normative framework to be enforced. Ever since the adoption of the European Directive mentioned in the presented study, risk assessment has become common practice among EU companies, aiming at keeping within the regulations related to personnel security and health, as well as reducing the costs related to accidents and occupational diseases.

This is also the direction Romania is taking in the process of aligning the normative framework applied to working environments that entail the use of various chemicals that may be hazardous for the health of the human resource.

The implementation of the European Commission Directive 2009/161/EC of December 17<sup>th</sup> 2009 mainly aims at increasing the degree of security for workers performing their activity in hazardous environments employing the use of harmful chemical substances. However, the alignment and harmonization of the national standards – applied to working environments where chemical agents are present – with the European principles and regulations is a continuous process, given the dynamics of the regulatory system and considering the best practices employed in the field of workplace security.

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