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THEORY AND PRACTICE OF ESTABLISHING OCCUPATIONAL EXPOSURE LIMITS IN POLAND *

JANUSZ A. INDULSKI, MD, PhD, ZBIGNIEW KOWALSKI, MD **,
JERZY MAJKA, PhD ***, JERZY SOKAL, DSc ****

Nofer's Institute of Occupational Medicine, Lodz, Poland

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Abstract. In Poland, a modern system of establishing MAC values for chemical compounds in the working environment was introduced in 1983, according to a regulation of the Ministry of Labour, Eearnings and Social Affairs as well as the Ministry of Health and Social Welfare. The regulation concerned the establishment of an Intersectoral Commission for Updating the Register of MAC and MAI Values. The Intersectoral Commission, with representatives of health and labour administration as well as those of various sectors of industry and research centres, has been made responsible for submitting documents on MAC and MAI values. The Commission has appointed an Expert Group on Chemical Agents, consisting of research workers dealing with toxicology, occupational medicine and occupational hygiene. The Expert Group prepare relevant MAC value documentation to be further discussed at the Group meetings. At the same time the methods for analyzing airborne chemicals are submitted along with the proposals of preliminary and periodical medical examinations, and possibly, documents on biological tolerance limits. The proposed MAC values are then subject to evaluation by the Intersectoral Commission and acceptance by the Ministry of Labour and Social Policy.
In the Polish system, the MAC values documentation is published in the Bulletin of the Intersectoral Commission which makes it possible for occupational physicians and sanitary inspectors to become acquainted with the problem. For the last four years 52 proposals of MAC values have been submitted. The MAC values for other 30 chemicals are planned to be established by 1990.

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** Vice-Chairman of the Intersectoral Commission for MAC and MAI values, member of the Group of Experts for chemical agents.

*** Secretary of the Group of Experts.

**** Chairman of the Group of Experts, member of the Intersectoral Commission.

Address reprint requests to J. Majka, Department of Chemical Safety, Institute of Occupational Medicine, 8, Teresy Str., P.O. Box 199, 90-950 Lodz, Poland

It has long been recognized that exposure limits for industrial chemicals constitute one of the most important and powerful tools in the course of risk control in the work environment. Only exposure limits make possible the implementation of the principle, adopted in virtually all civilized countries that work conditions should be safe for workers. The absence of legally binding or proposed exposure limits would necessitate the case to case considerations of the safety conditions in every plant or workshop. The cost of such activities would be tremendous and, what is more important, the social cost of easily arising errors in safety considerations, due to a great deal of uncertainty and misinformation, would be even higher.

However, it is also evident that the adequacy of the decisions undertaken in the process of risk management, that is the adequacy of a particular value of exposure limit for a given chemical, depends primarily on the appropriateness of the risk assessment process. Improper assessment would lead to decisions inadequate from the health and social or economic points of view. Compliance with these requirements demands a proper risk estimation, not possible a without careful examination of the risk, based all current knowledge. The exposure limit values must therefore be based on an available information on the health hazards created by industrial chemicals and on up-to-date knowledge in the fields of toxicology, occupational medicine, and industrial hygiene.

The present bases of exposure limits existing in various countries are in some cases very weak and exhibit many gaps in knowledge. In many cases an old, single, short-term animal or human experiment with no or poor pathological examination of experimental animals—whose number is often insufficient—constitutes the whole scientific basis for a given exposure limit. Dr. Henschler (7) states that among 150 industrial chemicals with assigned MAC-values chosen as a sample from the German list of MAC-values, less than 10% had MAC-values based on sufficient animal test and/or human data. The other 90% of chemicals required more extensive studies to define more accurately the hazard that would allow acceptance of their MAC-values without a high degree of uncertainty. Regarding the uncertainty of exposure limit values the situation in Poland seems to be much worse. The existing list of MAC-values (2) was developed some twenty years ago in a series of meetings of the best experts then available and the values included in the list are a reflection of their collective view based on a rather limited set of data supported by the values established at that time in the USA and USSR. It is obvious that the so-called scientific jugement of the data was an important element in the establishment of those values and their uncertainty is therefore rather high. It is also important is that

the scientific bases used to elaborate the list were not published so the appropriateness of the values cannot be checked. Apart from the level of uncertainty of any particular value given in the Polish, or probably any other list of exposure limits, may be noticed that concerning the safety levels, the lists are usually very heterogeneous. The validity and, following it, the safety levels or the safety margins of two given values may differ to a large extent.

Such a situation has called for a better scientific validation of exposure limits. In support of these requirements, over the last 10—20 years both the quantity and the quality of toxicological knowledge have increased tremendously and so has the availability of toxicological information. This has resulted from a common introduction of good laboratory practices, unification of toxicity testing methods, development of the systems of toxicological information, and improvement of the methods of risk estimation, especially the methods of estimation of cancer risk. All these changes were compelled by the pressure of a society willing to pay for demanding more and more careful testing of chemicals.

This new, much improved situation evolved in undertaking many programmes on both a national and an international scale. During the meeting of experts in 1976 the World Health Organization determined the basic foundation and principles on methods used in establishing permissible levels in occupational exposure to harmful agents. The main objectives of the programme undertaken were (i) the development of health-based exposure limits for chemical agents, (ii) the strengthening of international collaboration in order to improve the reliability and comparability of toxicological data, and (iii) WHO assistance in national efforts aimed at implementation of health recommendations into effective control measures. Since 1980 WHO has focused its activity on two subjects of the programme. First, the development of the health-based recommendations of occupational exposure limits on the basis of scientific evidence judged by experts and, second, translation of the health-based exposure limits into operational values or standards on the national level, which may differ from country to country due to technological and socio-economic factors. Within this programme, reports have been prepared on some chemical agents (heavy metals, selected solvents, pesticides, selected vegetable dusts, respiratory irritants and mineral dusts) with internationally recommended health-based limits for occupational exposure. Careful examination of existing data by WHO experts revealed the shortage of satisfactory information, mainly information on the relationship between concentration of chemicals in the air, duration of exposure and actual uptake of substances by the workers. Also, air sampling and analytical methodologies differ to a great extent from one study to

another. The combined exposures are still more difficult to evaluate (2). Activities of the second international agency dealing with exposure limits, namely the International Labour Office, were focused on effective control measures. Its policy was to strengthen the national authorities to develop national standards, which should in practical situations protect workers from exposure to chemicals in amounts liable to injure their health. To become the operational standards, the health based values are to be modified according to their acceptability at national level and their feasibility at plant level (6). An international programme of development of exposure limits was also introduced in the countries belonging to the Council of Mutual Economic Aid (CMEA). Experts from the cooperating countries meet together every two years to discuss documentation of exposure limits prepared in particular countries according to the unified scheme. The proposed values are based solely on health criteria and are to be taken into account during implementation of exposure limits in particular countries (3).

On the national scale, the largest achievements in the scientific validation of exposure limits have been made in the USA and FRG. For almost 20 years the Institute for Occupational Safety and Health (NIOSH) in the USA has been preparing the Criteria Documents for Occupational Standards widely recognized in the whole world as the most comprehensive approach to scientific validation of health-based occupational exposure limits. Comprising over 100 documents the Criteria are a precious tool (especially for people dealing in practice with workers' protection) permitting the understanding of relationships between exposure and effects. Less comprehensive materials are contained in Documentation of the Threshold Limit Values (1) prepared by the ACGIH and the component of practical judgment seems to be much larger in the proposed values. Through scientific validation is contained in the proposals of MAC-values included in the German List of MAC-values, where the prepared documentations are extensively discussed by the best experts available in FRG. The proposed values are solely health-based whereas the national authorities may use other criteria, namely economic feasibility and social acceptability, to change them into operational national standards (4).

Poland started to cope with the situation in the early eighties by the introduction of system of establishing new and verifying of the existing MAC-values. Briefly, the system, which was initiated by the term of new legislation which became effective in the years 1982—1983 is as follows (Table 1). The organizational scheme of the system is presented in Fig. 1. The main institution of the system is the permanent Intersectoral Commission for Updating the Register of Maximum Allow-

TABLE 1. Basic Legal Acts Implementing the System of Establishing MAC-values in Poland

Act	Scope
1. Labour Code, Section X, (articles 207—237) Dz.U. (Journal of Law of the Polish People's Republic), 1974, No 24, poz. 141	Safety and hygiene in work-places
2. Ordinance of the Minister of Labour, Earnings and Social Affairs on the Maximum permissible concentrations and intensities of harmful agents in the working environment. Dz.U. 1982, No 43, poz. 287	Ordinance and the list of MAC-values
3. Enactment nr 33 of the Minister of Labour Earnings and Social Affairs and the Minister of Health and Social Welfare on the Appointment of interagency committee for occupational hygienic standards (not published)	Membership and goals of the Committee
4. Ordinance of the Minister of Labour, Earnings and Social Affairs on the Maximum permissible concentrations and intensities of harmful agents in the working environment. Dz.U. 1985, No 40, poz. 195	Changes of MAC-values for industrial dusts
5. Directives of the Principal Sanitary Inspector on the testing and assessment of results of evaluation of exposure to harmful agents in the work environment. Wytyczne Głównego Inspektora Sanitarnego, PZWL, Warsaw 1985	Guidelines and list of short-term exposure limits
6. Ordinance of the Minister of Labour, Earnings and Social Affairs on the Short-term exposure limits for harmful agents in the working environment Dz.U. 1985, No 56, poz. 290	List of short-term exposure limits
7. Ordinance of the Minister of Labour, Earnings and Social Affairs on the Maximum concentrations and intensities of harmful agents in the working environment. Dz.U. 1987, No 1, poz. 4—5	Implementation of 10 new MAC-values

able Concentrations of Chemical Agents and Maximum Allowable Intensities of Physical Factors in the Working Environment promoted in 1983 by the Minister of Labour, Earnings and Social Affairs* together with the Minister of Health and Social Welfare. The Commission includes representatives of health and labour administration, various sectors of industry, trade unions and research institutes in the fields of occupational medicine and work safety. The main responsibility the Commission is a submission of the documented proposals for exposure limits for chemical agents and physical factors in the occupational environment to the Minister of Labour and Social Policy on whom the introduction of those values into legislation (in consultation with the Minister of Health

* Since 1988 the Minister of Labour and Social Policy.

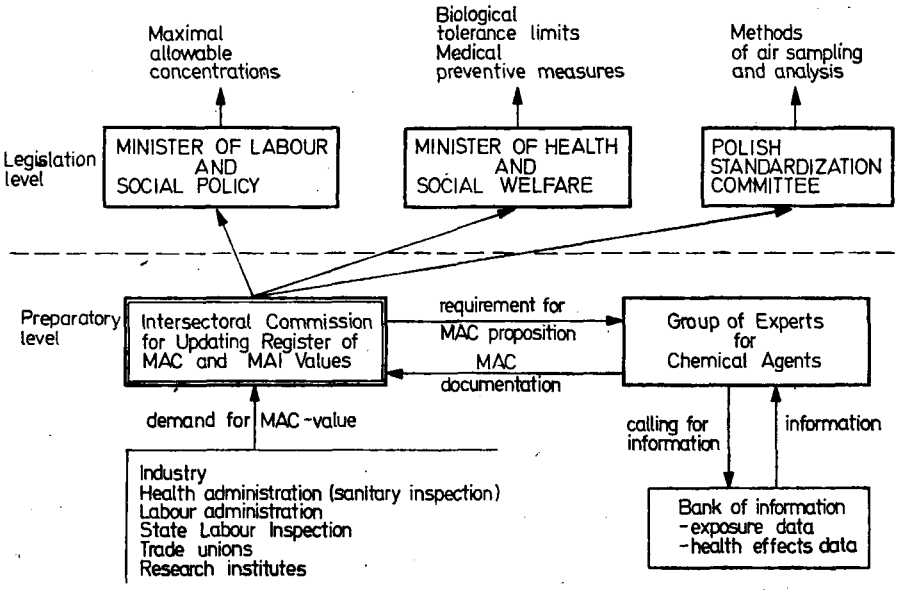

Fig. 1. System of setting MAC-values in Poland.

and Social Welfare) depends. In addition the Commission proposes methods of air sampling and analysis which are standardized by the Polish Standardization Committee and, if sufficent data exist, also the biological tolerance limits promulgated by the Minister of Health and Social Welfare.

The Commission has appointed the Group of Experts for Chemical Agents (the Group of Experts for Physical Factor has also been appointed consisting of idependent experts in the fields of toxicology, occupational hygiene and occupational medicine. The experts prepare health-based documentations for recommended exposure limits along with analytical procedures, recommendations with respect to pre-employment and periodical medical examinations and contraindications to exposure, and if it is also possible, with biological tolerance limits. Documentations prepared by experts are thoroughly reviewed at the meetings of the Group where the recommended values undergo careful scientific evaluation. Uniform documentation for each compound (Table 2) includes physico-chemical properties, production and exposure data, toxic effects in humans and animals, toxicokinetics, mechanism of toxicity, a review of hygienic standards existing in other countries, the proposition of a recommended hygienic standard, recommendations of medical examinations and proposition of the standarized method of air sampling and analysis. Prepared MAC documentations, being at this time a collective view of the Group of Experts are discussed at the session of the Intersectoral Com-

TABLE 2. MAC Documentation Content

1. Contents
2. Summary
3. Substance characterization, uses and occupational exposure
4. Toxic effects on man
5. Toxic effects on experimental animals
6. Carcinogenicity, mutagenicity, teratogenicity, embryotoxicity and effects on reproduction
7. Toxicokinetics
8. Mechanisms of toxicity
9. Combined effects
10. Dose-effect and dose-response relationships
11. Bases for existing MAC-values and biological tolerance limits
12. Bases for proposed MAC-values and biological tolerance limits
13. Methods of determination in the air and in biological material
14. Pre-employment and periodical examinations — exposure contraindications
15. References

mission, where criteria other than health-based ones may be applied for a given MAC-value.

To prepare documentations, the experts utilize all the available information which usually includes:

— original bibliography collected through the bibliography data bases (Toxline, Medlars, Chemical Abstracts)

— available documentations on exposure limits in other countries (USA, FRG, Sweden, documentations prepared by CMEA experts)

— WHO Environmental Health Criteria

— IARC evaluation of the carcinogenic risk due to chemicals

— other reviews

— unpublished documented data.

All the available original data directly related to the MAC-value are examined carefully. Other information on the biological effects may be derived from reliable reviews confirmed by critical original data and updated by the original bibliography.

The main discussion in the Group meetings is focused on the dose--effect and dose-response relationships. Priority is given to available epidemiological data and then to the results of experiments on human volunteers, observation of health effects in industry and to animal data. Reliability of the proposed MAC-value depends on the type of available data. In many cases the only reliable data come from animal experiments. In such a situation, a safety factor is introduced depending on the nature of toxic effects, duration of experiments, and on the size of population to be protected. Precise criteria of scientific judgment of utilized data cannot be established but attempts are always made to evaluate

the quality of data and to distinguish between adverse health effects and non-adverse changes and fluctuations.

According to the type of biological effects, the following categories of MAC-values are proposed:

— MAC(TWA): the time weighed average concentration for 8-hour workday
— MAC(STEL): the short-term exposure limit being an average concentration which may last together not longer than 30 minutes during workday
— MAC(C): ceiling concentration that should not be exceeded even instantaneously.

Consistency with all limits established for a given substance should prevent any adverse health effects to workers (also when retired) and also to next generations, assuming that the workers may be exposed during an 8-hour workday for their whole productive life.

It is evident that the system has been based on years of experience in other countries. Its fundamental principles are based primarily on the philosophy adopted first in the USSR so the values of exposure limits are established independently of technical and economic feasibility. However, the "technological" aspects of the system and criteria used in scientific judgment are similar to those in the USA and FRG and the differences are due to adaptations to conditions of national economy. It should be noticed that adopting the basic principles stating that only health criteria are taken into account, brings about some difficulties in implementation of the proposed values into practice. So far the Minister of Labour and Social Policy has promulgated only 10 new MAC-values of the 52 proposed (Table 3). This is understandable as health based exposure limits cannot always be introduced into the whole national economy. In such cases the situation is controlled by State Sanitary Inspection, which may take into account technological and economical feasibility in particular enterprises, but only to an extent which does not allow for the development of any clear adverse health effects.

A very important problem is the selection of priority chemicals for the establishment of MAC-values. It goes beyond the scientific criteria and demands thorough surveys and assessment of potential hazards. Unfortunately, no centralized system of reporting on noxious chemicals in industry presently operates in Poland. It is only in the cases of agents for which MAC-values have been established that the information on exposure is collected by the State Sanitary Inspectorate. Information concerning the use of all the other chemicals is insufficient and dispersed. Although the local sanitary and epidemiological stations are

TABLE 3. MAC-values Adopted by the Intersectoral Commission

Compound	Proposed value (mg/m³)		Previous or still existing value (mg/m³)	
	TWA ×	STEL×*	TWA	STEL
Acrylonitrile	2	10	10	—
Benzene	10	40	30	75
Butyl acrylate	20×	70	—	—
n-Butyl alcohol	50	150	200	—
Cadmium compounds				
— dusts (as Cd)	0.04	0.2	—	—
— fumes (as Cd)	0.02	0.05	0.1	—
Carbon disulfide	10	30	25	75
Chlorfenvinphos	0.01	0.1	—	—
2-Chloroethanol	1	3	10	—
Chromates (as Cr)	0.01	0.05	0.1	0.3
Cobalt (dust and fumes as Co)	0.05	0.2	0.5	—
Dichlorofluoromethane	40	200	2000	—
Diethyl phthalate	5	15	—	—
Dimethyl phthalate	5	15	—	—
Dinitroglycol	0.1	0.4	—	—
1,3-Dioxolane	10×	50	—	—
2-Ethoxyethanol	20	80	200	370
Ethyl acrylate	20×	80	—	—
2-Ethylhexyl acrylate	35×	100	—	—
n-Hexane	100	400	400	—
Hydrazine	0.05	0.1	—	—
Hydrogen sulfide	10	20	10	20
Isobutyl alcohol	100×	200	—	—
Kerosene	100	300	300	900
Malathion	1	10	15	45
2-Methoxyethanol	15	60	50	—
2-Methoxyethyl acetate	25	100	100	—
Methyl acrylate	20	70	20	70
Methyl n-butylketone	10	50	200	—
Mineral oils	5×	10	—	—
Nitroglycerine	0.3	1	2	—
Phenol	10	20	10	35
N-Phenyl-2-naphthylamine	0.02	—	—	—
Potassium hydroxide	0.5	1	—	—
Propoxur	0.5	2	—	—
Selenium compounds (as Se)	0.1	0.3	0.1	0.3
Sodium hydroxide	0.5×	1	—	—
Styrene	50	200	100	400
Sulphur dioxide	2	5	20	—
Tetraethyl lead	0.05	0.1	0.005	0.04
Thiram	0.5	2	0.5	4
Toluene	100	350	100	550
2,4-Toluenediamine	0.04	0.1	—	—

TABLE 3 (continued — 2)

Toluene-2,4-diisocyanate	0.035×	0.07	—	—
1,1,1-Trichloroethane	300×	1400	—	—
1,1,2-Trichloroethane	45	100	100	—
Triethylenetetramine	1	3	—	—
1,3,5-Trioxane	15×	75	—	—
Vanadium pentoxide				
— dusts (as V)	0.05	0.5	0.5	—
— fumes (as V)	0.05	0.1	—	—
Vinyl acetate	10	30	10	30
Vinyl chloride	5	30	30	—
Xylene	100	350	100	600
Zinc oxide	5	10	5	10

× values accepted by the Minister of Labour and Social Policy as legal standards
* time weighed average
** short-time exposure limit

responsible for passing opinions on all the new technologies to be introduced into industry, the data possessed are too scare to set local priorities in this respect. Therefore, the latter are determined by the members of the Intersectoral Commission and Expert Group for MAC-values, on the basis of the relevant reporting by particular industrial enterprises as well as the Ministry of Industry, State Sanitary Inspectorate and State Labour Inspectorate, along with the individual experience of members of the Expert Group and Commission. The success of this procedure at present depends primarily on the individual experience and knowledge of members of the Commission and Expert Group. Such a situation calls for the introduction of the system allowing for the systemic search of potential priority hazards on basis of the production volume, size of the population exposed and on the potential created hazard.

Among the 52 chemicals evaluated by the Group of Experts (Table 3) were 20 chemicals without a previously assigned MAC-value in Poland and 32 chemicals with MAC-values already established. After a re-evaluation process, the MAC-values of 22 chemicals were reduced, in one case (dichlorofluorometan) by a factor of 50, and 9 MAC-values were left unchanged. In one case (tetraethyl lead) the existing MAC-value was increased 10 times because careful examination of the existing data, including human data, did not justify the low level of the previously existing standard.

Our experience to date has confirmed that the scientific validation of exposure limits creates many difficulties due to insufficiency and frequent inconsistency of data. Scientific criteria of the 52 MAC(TWA)-values adopted by the Intersectoral Commission are briefly summarized in Table 4 according to the types of data and effects considered. Detailed

TABLE 4. Health-based Scientific Criteria of MAC-values Adopted by Polish Intersectoral Commission for Occupational Standards

Compounds	Health-based criteria	
	Human data	Animal data
1	2	3
Acrylonitrile	carcinogenic effects	—
Benzene	carcinogenic effects	carcinogenic effects
Butyl acrylate	Analogy to other acrylic esters	
n-Butyl alcohol	neurotoxic effects	—
Cadmium compounds — dusts (as Cd) — fumes (as Cd)	diseases of respiratory tract and kidney effects	—
Carbon disulfide	neurotoxic and cardiovascular effects	—
Chlorfenvinphos	—	inhibition of acetylcholinesterase (long-term experiments without inhalation experiments)
2-Chloroethanol	—	several systemic effects (acute and subchronic exposure)
Chromates (as Cr)	carcinogenic effects	—
Cobalt (dust and fumes as Co)	effects on respiratory tract	effects on respiratory tract (subchronic exposure)
Dichlorofluoromethane	—	liver toxicity (subchronic exposure)
Dimethyl phthalate	Analogy to dimethyl phthalate	
Diethyl phthalate	—	irritation of the respiratory tract, systemic effects, cumulation
Dinitroglycol	cardiovascular effects	—
1,3-Dioxolane	—	irritation of upper respiratory tract (long-term exposure)
2-Ethoxyethanol	—	developmental effects
Ethyl acrylate	irritation of upper respiratory tract	irritation of upper respiratory tract (long-term exposure)
2-Ethylhexyl acrylate	—	irritation of upper respiratory tract, neurotoxic effects (long-term exposure)

TABLE 4 (continued — 2)

1	2	3
n-Hexane	neurotoxic effects	—
Hydrazine	irritation of the respiratory tract	systemic and carcinogenic effects
Hydrogen sulfide	irritation of upper respiratory tract and effects on the central nervous system	—
Isobutyl alcohol	—	irritation of upper respiratory tract (short-term experiments)
Kerosene	—	effects on liver, kidneys and lungs (subchronic exposure)
Malathion	inhibition of acetylcholinesterase	inhibition of acetylcholinesterase (subchronic exposure)
2-Methoxyethanol	—	developmental effects
2-Methoxyethyl acetate	Analogy to 2-methoxyethanol	
Methyl acrylate	—	irritation of eyes and upper respiratory tract (subchronic exposure)
Methyl n-butylketone	peripheral polyneuropathies	peripheral polyneuropathies (subchronic exposure)
Mineral oils	—	effects on respiratory tract (chronic exposure)
Nitroglycerine	cardiovascular effects	—
Phenol	toxicokinetics (supported by)	systemic effects
N-phenyl-2-naphtyhylamine	—	carcinogenic effects
Potassium hydroxide	Analogy to sodium hydroxide	
Propoxur	inhibition of acetylcholinesterase	inhibition of acetylcholinesterase
Selenium compounds (as Se)	systemic effects primarily of the nervous system	—
Sodium hydroxide	irritation of upper respiratory tract	—
Styrene	irritation of upper respiratory tract, CNS effects	—
Sulphur dioxide	irritation of upper respiratory tract	—

TABLE 4 (continued — 3)

1	2	3
Tetraethyl lead	neurotoxic effects	—
Thiram	—	irritation of the respiratory tract, reproductive effects
Toluene	irritation of the respiratory tract, neurotoxic effects	—
2,4-Toluene-diamine	—	carcinogenic effects
Toluene-2,4-diisocyanate	irritation of eyes and respiratory tracts, respiratory sensitization	—
1,1,1-Trichloroethane	no-effect-level in epidemiological studies	—
1,1,2-Trichloroethane	Analogy to tetrachloroethane and chloroform	
Triethylenetetramine	—	systemic effect
1,3,5-Trioxane		irritation of upper respiratory tract (long-term exposure)
Vanadium pentoxide — dust (as V) — fumes (as V)	irritation of respiratory tract	—
Vinyl acetate	irritation of eyes and upper respiratory tract	irritation of eyes and upper respiratory tract (long-term exposure)
Vinyl chloride	carcinogenic effects	carcinogenic effects
Xylene	irritation of the respiratory tract, neurotoxic effects	—
Zinc oxide	respiratory tract effects	respiratory tract effects (subchronic exposure)

analysis of information providing scientific bases for the determined exposure limits shows that there are enormous gaps in the knowledge of some evaluated chemical compounds. Sometimes the basic data on toxicity did not even exist. In most cases in such a situation the proposed values are the best possible scientific judgment based on all the existing data. Due to the lack of knowledge for 5 compounds, the values were proposed by analogy to structure-related chemicals with better known toxicity. For these compounds the existing data were insufficient even to make a rough scientific judgment of the recommended values. Only animal data were available for 17 chemicals, and for about 10 of them there were no sufficient data on chronic inhalation exposure. For the

remaining 30 chemicals, human data, in some cases considerably supported by the results of animal experiments, provided the basis for the proposed values of exposure limits. But for only a few chemicals (e.g. benzene, carbon disulphide, tetraethyl lead, 1,1,1-trichloroethane, xylene, toluene) could the existing epidemiological data be considered as satisfactory. Scientific bases for the short-term exposure limits (STEL) were usually very poor if not totally absent and substantial arbitrariness was involved in the majority of proposed values.

Considering the type of effect, eye and respiratory tract irritation were critical effects for about half of the values proposed. The other effects included neurotoxicity, carcinogenicity, developmental toxicity and the toxic effects on other systems. Changes in established values will be justified by new data on the toxicity of examined compounds. The process of verifying the scientific bases of the existing exposure limits should therefore develop together with the development of the system of accumulation of toxicological information.

The system introduced in Poland, as well as other systems of setting hygienic standards, does not solve the problem of the control (on the basis of scientific criteria) of combined exposure to a larger number of chemicals. Exposure limits are determined almost exclusively for single chemical substances except in rare cases, e.g. carcinogenic aromatic hydrocarbons, where hygienic standards for a complex of harmful agents occurring at the workplace, are suggested. However, for the present, in the occupational environment, exposure to two or more chemical substances often with simultaneous exposure to physical factors, as in the case of welding, is a rule, not an exception. To solve the problem of the control of combined exposure to chemicals, it has for a long time been recommended that the magnitude of the admissible concentrations should depend on the character of the combined effects of chemicals. The formula:

$$C_1/MAC_1 + \ldots + C_n/MAC_n < 1$$

has become a guideline widely used in the assessment of the combined occupational exposure to substances with an additive effect, and since data on the character of the combined effects are usually absent for almost all chemicals. However, the application of the above principles when there are no reliable data on the health effects due to combined exposure is not scientifically justified and only apparently solves the problem. It may be a source of insufficient control of occupational exposure, particularly when the established exposure limits have no or a very small margin of safety. In rare cases it may lead to a higher degree of control than necessary.

Two other problems related to hygienic standards should be mentioned: work-related diseases and multimedia exposure. Although both those problems cannot be effectively solved today, they are to be taken into account for future consideration. The problem of work-related diseases is becoming more and more significant due to the continuous decrease of the occupational exposure levels and the decrease in occurrence and severity of specific occupational pathologies. The present state of knowledge does not allow the connection of work-related diseases with the actual level of exposure to the present standardized agents of the working environment. In order to control them, first the mechanisms of their occurrence should be learned and the casual factors should be determined.

The problem of multimedia exposure is created by the fact that occupational exposure and various sources of environmental exposure are generally controlled independently of each other, and the standards are established taking into account one source of exposure only, whereas large groups of the general population are exposed to significant amounts of toxic substances from various sources, as, for example, in the case of exposure to heavy metals. This problem of additional exposure, although it cannot be solved by setting occupational hygienic standards, has to be considered in assessment of the health effects in the occupational population and in planning protective measures.

This brief analysis of all the above mentioned problems in setting occupational hygienic standards shows that the main problem is the lack of sufficient and reliable scientific bases. The scale of research needs is enormous, especially if we take into consideration the fact that the exposure limits have been established for only a small percentage of chemicals present in the working environment and many exposure limits for particular chemical compounds have been determined on the basis of the incomplete results of traditional toxicometric investigations. Therefore it is obvious that in the immediate future the process of standards-setting may be undertaken only for selected priority chemicals creating potentially the highest health risk. Due to economic factors, it seems that only broad international cooperation at the stage of planning, implementation and evaluation of results of the studies, primarily epidemiological, may create indispensable conditions promoting the more effective and faster solution of the problems.

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